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PHILIPS

DUAL-TRACE OSCILLOSCOPE

PM 3110

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05/0172/1/02

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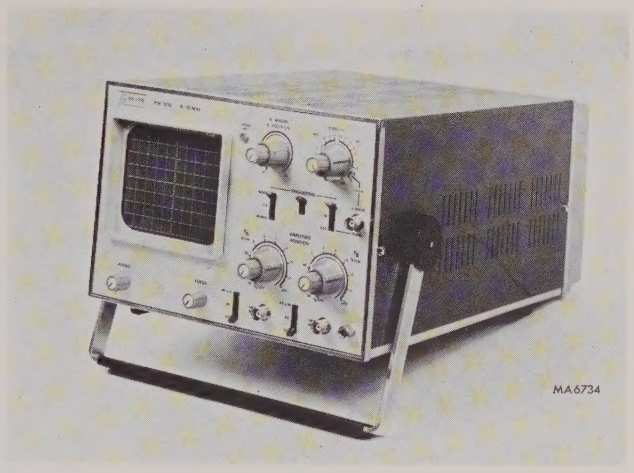

MANUAL

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IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate at the bottom of the instrument.

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1. General information

1.1. INTRODUCTION

The dual-trace oscilloscope PM 3110 is, on account of its ease of operation, particularly suitable for radio and television service and for educational and training purposes.

The instrument comprises a large cathode-ray tube with a useful screen area of 8 x 10 cm.

With the exception of the input stages of the two identical Y preamplifiers, the instrument is completely transistorized.

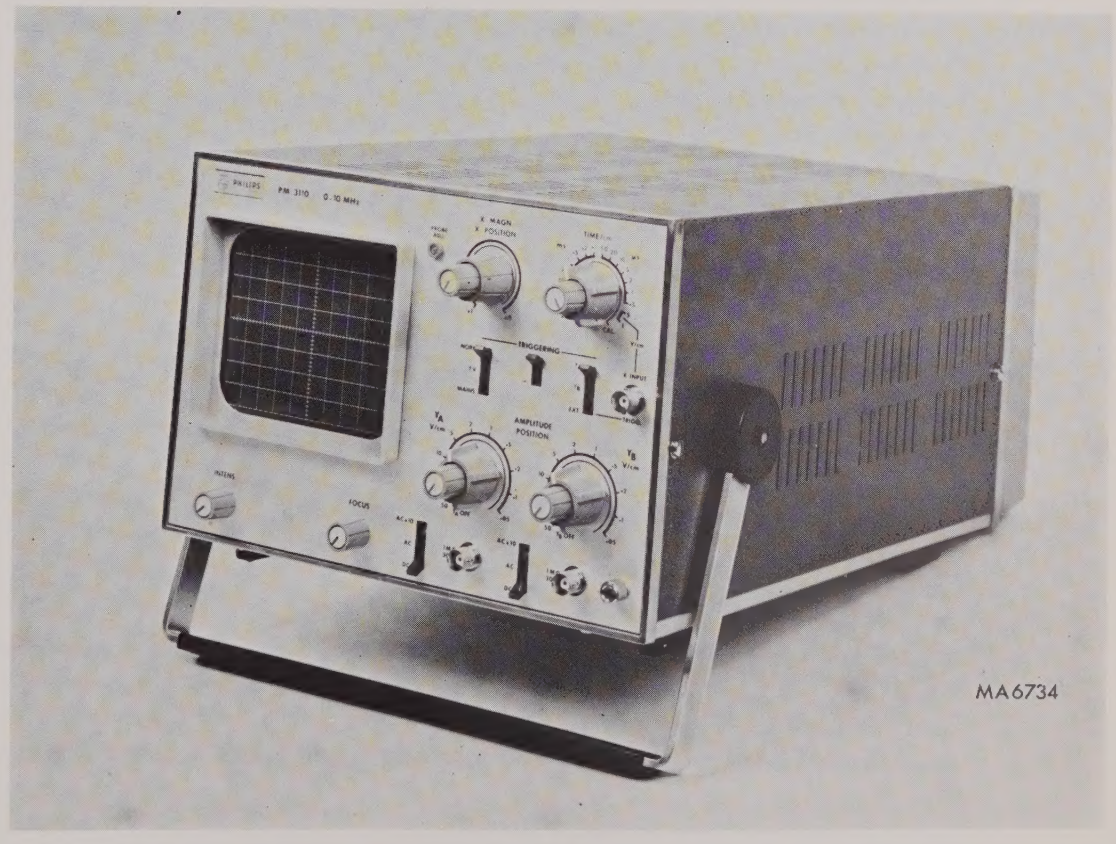


Fig. 1. Front view

1.2. TECHNICAL DATA

Properties expressed in numerical values with tolerances stated are guaranteed by the manufacturer. Numerical values without tolerances are typical values and merely serve as a guide.

Cathode-ray tube

Type	D13 - 480 GH
Screen diameter	13 cm
Useful screen area	8 x 10 cm
Accelerating voltage	-2 kV
Controls	focus, intensity

Y-Amplifier

(These data apply to both channel Y_A and channel Y_B)

Connector	B.N.C.	
Deflection coefficient		
- in positions AC and DC	50 mV/cm to 50 V/cm	10 steps in 1-2-5 sequence
- in position ACx10	5 mV/cm to 5 V/cm	
Frequency range (reference trace height 6 cm)		
- in position DC	0 Hz to 10 MHz (-3 dB)	
- in position AC	2 Hz to 10 MHz (-3 dB)	
- in position ACx10	3 Hz to 5 MHz (-3 dB)	
Rise time		
- in position AC and DC	35 ns	
- in position ACx10	70 ns	
Frequency response of Trace height	> 8 cm up to 7 MHz	
Magnification		
- linear range	24 cm	
- frequency limit for undistorted display of a sine-wave signal at 24 cm	1 MHz	
Positioning range	> 18 cm	
Linearity error as defined in DIN 43740 *)	< 1 %	
Total measuring error	< 5 % at nominal mains voltage within the temperature range +5°C to +35°C	
Input impedance	1 MΩ//30 pF	
Max. permissible input voltage	500 V (d.c. + a.c. peak)	

*) DIN 43740 describes the linearity error as the deviation of the deflection coefficient at 75 % deflection from that at 25 % deflection, expressed as a percentage of the latter and measured in the straight part of the frequency-response curve and from the centre of the screen.

Operating modes	
Channel Y_A only	Y_B POSITION set to Y_B OFF
Channel Y_B only	Y_A POSITION set to Y_A OFF
Channel Y_A and channel Y_B (electronically switched)	Simultaneous display of both channels in chopped or alternated mode as dictated by position of TIME/cm switch: chopped : in pos. 50 to 0.2 ms alternated: in pos. 0.1 ms to 0.5 µs
Frequency of the electronic switch	200 kHz

X-Amplifier

Connector	B.N.C.
Deflection coefficient	1 V/cm or 5 V/cm, set by means of TIME/cm switch
Magnification	1x to 5x, continuous control
Frequency range (reference trace width 8 cm)	3 Hz to 1 MHz (-3 dB)
Total error	< 10 %
Input impedance	100 kΩ at 1 V/cm 500 kΩ at 5 V/cm
Max. permissible input voltage	250 V (d.c. + a.c. peak)

Time-base generator

Time coefficient	16 calibrated steps from 0.5 µs/cm to 50 ms/cm in 1-2-5 sequence A vernier provides uncalibrated, continuous control between the steps (1 ; > 2.5)
Error	< 5 % at nominal mains voltage within the temperature range +5°C to +35°C
Linearity error as defined in DIN 43740 x)	< 1 %
Magnification	1x to 5x, continuous control
Positioning range	± 5 cm x magnification factor

Triggering

Triggering system	automatic
External trigger input socket	B.N.C.
Trigger source	Y_A, Y_B, external
Polarity	positive and negative (referred to signal peaks)
Trigger mode	
NORM.	normal (triggering by signal peaks)
T.V.	triggering by line or frame sync pulses as dictated by the position of the TIME/cm switch: frame: in pos. 50 to 0.2 ms/cm line : in pos. 0.1 ms to 0.5 µs/cm
MAINS	triggering by signal with mains frequency and fixed polarity

Trigger sensitivity

	2 Hz	100 Hz - 2 MHz	10 MHz
sine wave, internal	< 2 cm	< 1 cm	< 4 cm
sine wave, external	< 3 V_{p-p}	< 1.5 V_{p-p}	< 3 V_{p-p}
t.v. signal, internal			
sync level		< 1 cm	

Input impedance for external triggering	100 kΩ
Max. permissible input voltage	250 V (d.c. + a.c. peak)

Probe adjustment voltage

PROBE ADJ. output terminal	contact point
Calibration voltage	square-wave voltage of 5 V_{p-p}
Frequency	2.2 kHz

Power supply

Mains voltage	110 V, 128 V, 202 V, 220 V, 238 V
Mains voltage tolerance	+10 %, -15 %
Mains frequency	50 to 60 Hz
Power consumption	47 VA

Ambient conditions

Reference temperature	+23°C
Temperature range	
- operating within specification	+5°C to +35°C
- operating	-10°C to +45°C
- storage	-25°C to +70°C

Dimensions

Width	305 mm (overall)
Height	195 mm (without handle)
Depth	455 mm
Weight	8.5 kg

1.3. ACCESSORIES

1.3.1. Standard accessories

A manual

1.3.2. Optional accessories

B.N.C. - 4 mm adapter	PM 9051
Passive probe set with 1.15 m cable	PM 9326
Passive probe set with 2 m cable	PM 9327
Viewing hood	PM 9366
Multi-purpose recording camera	PM 9380
Camera adapter	PM 9377
Supplementary lens	PM 9373

1.4. DESCRIPTION OF THE BLOCK DIAGRAM

1.4.1. Cathode-ray tube

The c.r.t. operates with an accelerating voltage of -2 kV. The trace intensity and definition can be adjusted by means of the INTENS. and FOCUS controls.
The INTENS. control incorporates the o/~ mains switch.

1.4.2. Y-Amplifier: Unit 1A, Unit 1B and Unit 2

The oscilloscope has been provided with two identical channels Y_A and Y_B, each comprising the following parts:

- ACx10/AC/DC switch
- Y-AMPLITUDE attenuator with ten calibrated steps
- Impedance transformer (cathode follower)
- Preamplifier. In position ACx10 of the ACx10/AC/DC switch, the sensitivity is increased by a factor 10. The Y POSITION control allows vertical shifting of the trace; in position Y OFF of this switch, the relevant channel is switched off.
- Channel selector driven by a flip-flop
- Flip-flop, set by the Y_A OFF and Y_B OFF switches and, via the blanking stage, triggered by an astable multivibrator (chopped mode) or the time-base generator (alternated mode).
- Y Final amplifier which amplifies the signal and supplies the deflection voltage for the c.r.t.
- Trigger pick-off stage supplying a signal for internal triggering of the time-base generator.

1.4.3. X Channel: Unit 3 and Unit 3A

The time-base generator in the X channel can be triggered with either an external signal or an internal signal obtained from either Y channel.
Bypassing the trigger and time-base circuits allows the X channel to be used as an amplifier for external X deflection signals.
The X channel channel comprises the following circuits:

- X and trigger preamplifier; in the positions TIME/cm of switch 801 it acts as a trigger-pulse amplifier and in the positions V/cm as preamplifier for external X deflection signals.
  The input amplifier has been provided with a +/- polarity switch (803) which enables triggering on the positive- and negative-going edge of the signal.
- Y_A/Y_B/EXT switch to select the trigger source.
- Attenuator allowing the external X deflection signal to be attenuated in two steps
- Peak detector/sync separator which keeps the triggering point at the peaks of the triggering signal.
  Three trigger modes can be selected by means of switch 802;
  NORM.: triggering by the signal peaks
  T.V. : triggering by line or frame sync pulses of a television signal
  MAINS : triggering by a signal with the mains frequency
- Trigger-pulse shaper supplying pulses with steep edges. The negative-going edges of these pulses start the time-base generator whereas the positive-going ones drive the auto circuit.
- Time-base generator of the constant-current integrator type, comprising the charge capacitors and resistors. The time coefficients can be selected in twelve steps by means of the TIME/cm switch. Continuous control is possible with TIME/cm potentiometer 609.
- Hold-off circuit which ensures that the time-base generator cannot be started before the flyback is terminated.
- Auto circuit which makes the time-base generator free-running when no trigger pulses are applied.

- X Final amplifier which amplifies the internal sawtooth voltage or the external X deflection voltage before it is applied to the horizontal deflection plates. This stage also contains the horizontal shift control (X POSITION) and the magnification control (X MAGN).

1.4.4. Z Control (blanking) stage

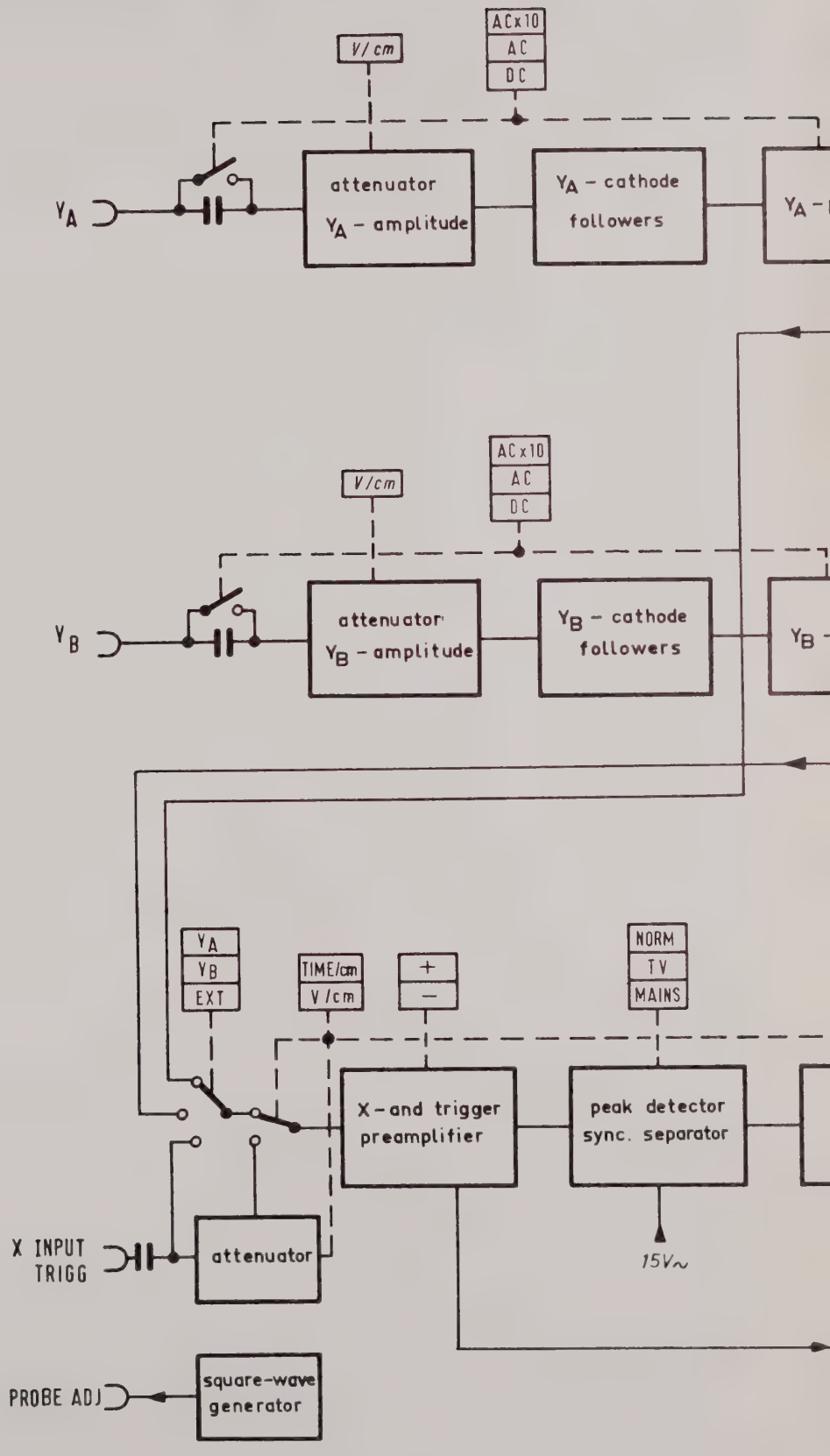
This circuit provides blanking of the c.r.t. during the flyback of the time-base voltage and during the switching time in the chopped mode.
Moreover, this circuit combines the automatic switching signals of the chopper multivibrator and the time-base generator in such a way as to give alternated operation in the positions up to 0.1 ms of the TIME/cm switch, and chopped operation in positions from 0.2 ms onwards.
With external X deflection the instrument also operates in the chopped mode.

1.4.5. Square-wave generator

The square-wave generator supplies a calibration voltage to the PROBE ADJ. contact point. With the aid of this voltage, the square-wave response of an attenuator probe can be optimised.

1.4.6. Power supply and d.c. converter

The power supply provides the d.c. supply voltages and a signal for MAINS triggering. The stabilised d.c. converter supplies the accelerating voltage for the c.r.t.


V/cm
AC x 10
AC
DC
Y_A
attenuator
Y_A – amplitude
Y_A – cathode
followers
Y_A –
V/cm
AC x 10
AC
DC
Y_B
attenuator
Y_B – amplitude
Y_B – cathode
followers
Y_B –
Y_A
Y_B
EXT
TIME/cm
V/cm
+
–
NORM
TV
MAINS
X – and trigger
preamplifier
peak detector
sync. separator
15V~
X INPUT
TRIGG
attenuator
PROBE ADJ
square-wave
generator

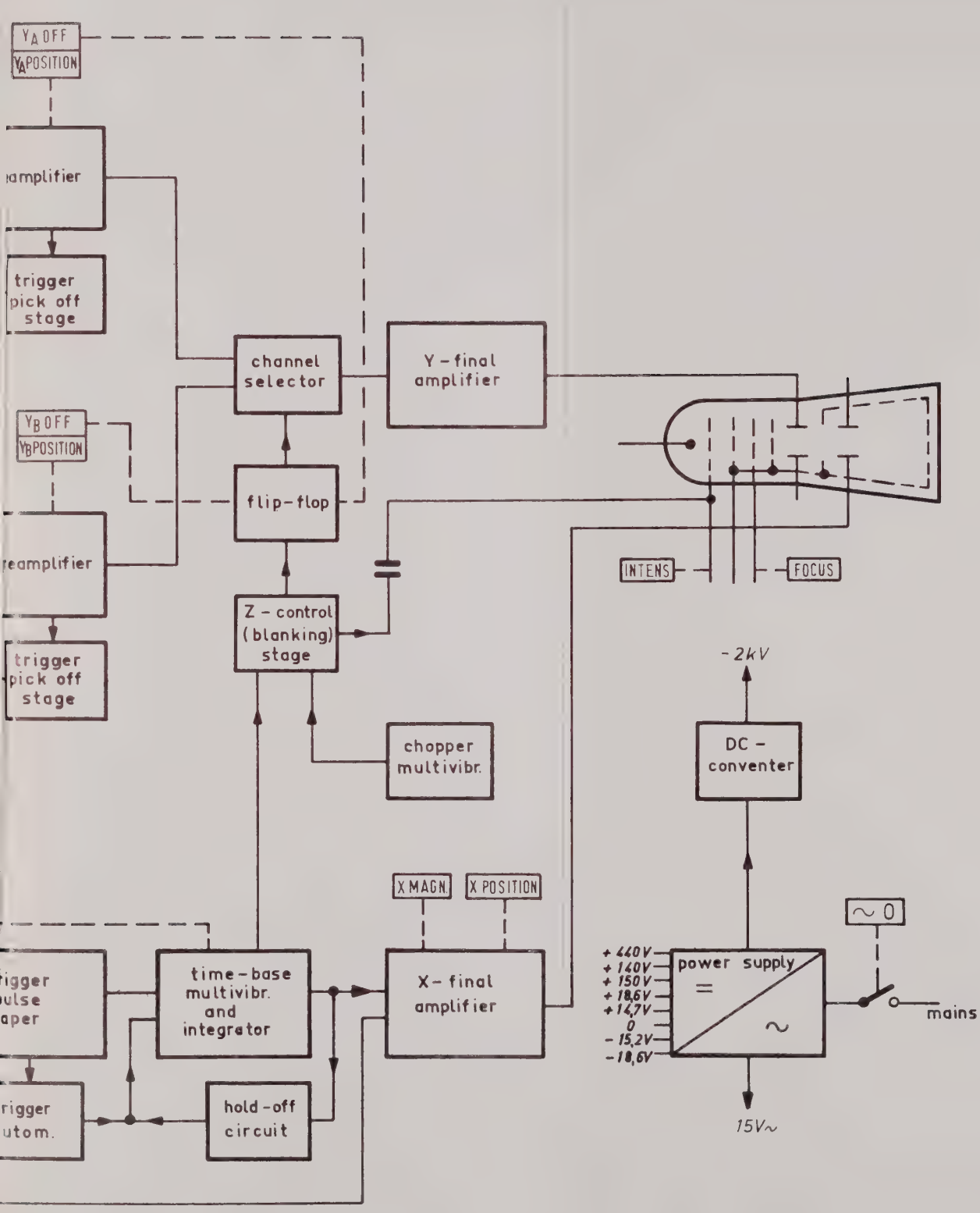


Fig. 2. Block diagram

2. Directions for use

2.1. INSTALLATION

2.1.1. Operating positions

The oscilloscope can be used in any position, provided the air vents in the cabinet are not obstructed. For use in a vertical position, the instrument can be stood on its cable compartment. The handle can be used as a tilting bracket to operate the instrument in a sloping position. The handle can be folded back over the top of the oscilloscope, after pulling both arm sideways in accordance with Fig. 3.

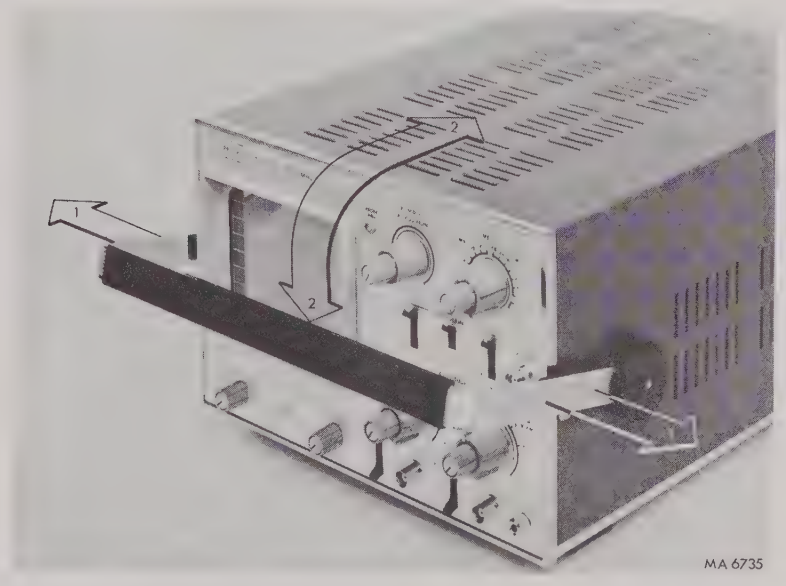


Fig. 3. Handle used as tilting bracket

2.1.2. Adjusting to the local mains voltage

The instrument must be connected to an a.c. mains only. Upon delivery the instrument is adjusted for connection to a 220 V mains.
For operation with mains voltage of 110 V, 128 V, 202 V and 238 V, the mains transformer connections must be appropriately changed:

- remove both screws at either side of the instrument and lift off the cabinet,
- make the relevant connections as shown in Fig. 4.

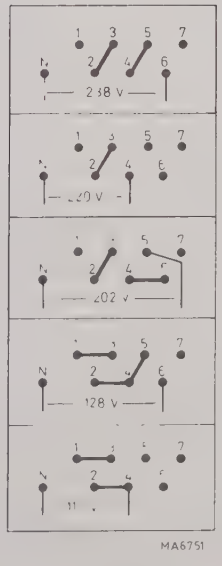


Fig. 4. Adjusting to the local mains voltage

2.1.3. Earthing

The instrument should be connected to a protective earth in accordance with the local safety regulations. When the instrument is connected to a mains socket with rim-earth contacts, the cabinet is connected to earth via the three-core mains cable. The outer contacts (bushes) of the Y_A, Y_B and X INPUT connectors and earth terminal ⏚ are in electric contact with the cabinet. Earth terminal ⏚ can be used as measuring earth.

2.2. CONTROLS AND SOCKETS (Fig. 5)

Item	Designation	Function
603	INTENS - o/~	Trace intensity control incorporating mains switch
870		Mains voltage indicator
604	FOCUS	Trace definition control
851	PROBE ADJ.	Test point for passive probes
601a	X MAGN.	Magnification control for the X deflection
601b	X POSITION	Horizontal shift control
801	TIME/cm - V/cm	Time coefficient selector incorporating X attenuator
609	TIME/cm CAL.	Vernier control of the time coefficient. The time coefficients are calibrated when this control is in position CAL.
802	NORM./TV/MAINS	Trigger mode selector
803	+/-	Trigger polarity switch
804	Y_A/Y_B/EXT.	Trigger source selector
852	X INPUT/TRIGG.	Input for external X or trigger signal
805a	Y_A AMPLITUDE	Step attenuator in channel Y_A
602a	Y_A POSITION Y_A OFF	Vertical positioning control for Y_A trace, incorporating switch to make channel Y_A inoperative
805b	Y_B AMPLITUDE	Step attenuator in channel Y_B
602b	Y_B POSITION Y_B OFF	Vertical positioning control for Y_B trace, incorporating switch to make channel Y_B inoperative
806a	ACx10/AC/DC	Selector for a.c. or d.c. coupling in channel Y_A
806b	ACx10/AC/DC	Selector for a.c. or d.c. coupling in channel Y_B
853	1 MΩ/30 pF	Input socket for channel Y_A
854	1 MΩ/30 pF	Input socket for channel Y_B
855	⏚	Measuring earth terminal

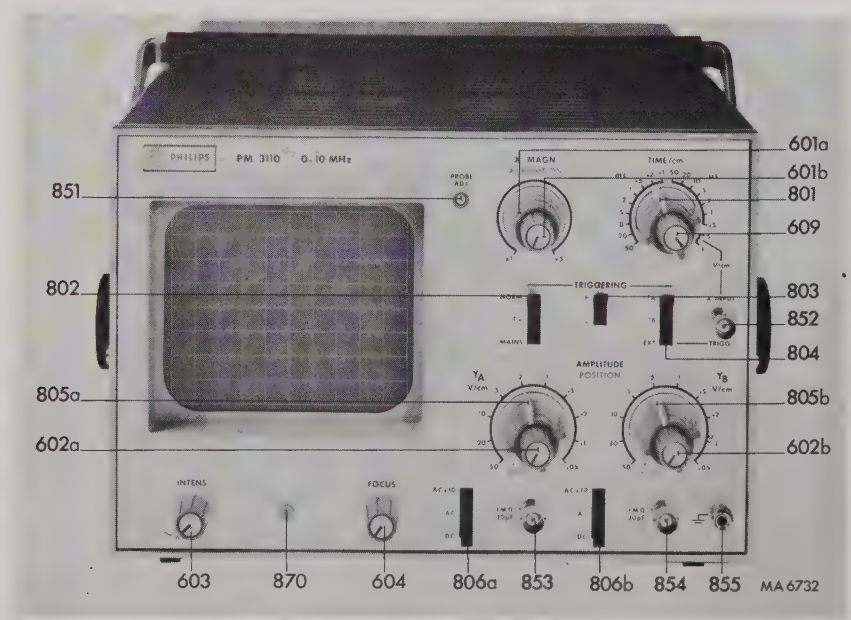


Fig. 5. Controls and sockets

2.3. OPERATION

2.3.1. Preliminary settings

- Connect the instrument to the mains
- Set the controls X POSITION 601b, Y_A POSITION 602a and Y_B POSITION 602b to their mid-positions
- Turn X MAGN. control 601a fully anti-clockwise (position x1)
- Turn TIME/cm vernier control (609) fully clockwise (position CAL)
- Set TIME/cm switch 801 for any time coefficient
- Set NORM./TV/MAINS switch 802 to NORM.
- Set Y_A/Y_B/EXT. switch 804 to either Y_A or Y_B
- Switch on the instrument and set INTENS. control 603 to its mid-position; the traces become visible after approximately 15 seconds.
  Lamp 807 indicates that the instrument is switched on.
- Set INTENS. control 603 for an average brightness of the trace
- Set FOCUS control 604 for maximum definition

2.3.2. Channel selector $Y_{A(B)}$-OFF

If Y_A (Y_B) POSITION control 602a (602b) is switched to Y_A OFF (Y_B OFF), channel Y_A (Y_B) is inoperative. If neither control is in the OFF position, the instrument operates as a dual-trace oscilloscope.

2.3.3. Input coupling

If ACx10/AC/DC switch 806a (806b) is in position ACx10 or AC, the d.c. component of the input signal is blocked. This is necessary when the a.c. component to be tested is small compared to the d.c. component.

2.3.4. Triggering

Owing to a trigger auto-circuit, the time-base generator is free-running in the absence of a triggering signal so that the trace remains visible on the screen.

The time-base generator may be triggered by the following signal sources:
- either channel Y_A or channel Y_B; therefore, the Y_A/Y_B/EXT. switch 804 must be set accordingly and NORM./TV/MAINS switch 802 to either NORM. or TV
- external signal applied to X INPUT/TRIGG. socket 852; Y_A/Y_B/EXT. switch 804 must be set to EXT. and NORM./TV/MAINS switch 802 to NORM. or TV.
- internal signal with the mains frequency; NORM./TV/MAINS switch 802 must be set to MAINS.

The trigger polarity is selected with the aid of +/- switch 803. In position +, the time-base generator is started just before the positive peak of the triggering signal and in position - just before the negative peak. In position MAINS of NORM./TV/MAINS switch 802, the trigger polarity switch is inoperative. Then the phase can be inverted by reversing the mains plug.

In position TV of NORM./TV/MAINS switch 802 the time-base generator is triggered by the line or frame sync pulses of a television signal.
For triggering by line pulses, TIME/cm switch 801 must be in one of the positions 0.2 ms to 50 ms; for frame pulses this switch must occupy one of the positions 0.5 μs to 0.1 ms.

If the peaks of the sync pulses are positive (negative) with respect to the video signal, the trigger polarity switch must be set to position + (-).

The TV position is also very useful when h.f. interference affects triggering of l.f. signals.

In single-trace operation, the blocked channel remains operative and can, therefore, be conveniently used as trigger amplifier, with the following advantages:
In position ACx10 of switch ACx10/AC/DC it is possible to trigger with very small signals.
With larger triggering signals and higher trigger amplification it is possible to trigger on signal levels which lie between the peak and zero levels of the signal; the required gain is selected with the Y AMPLITUDE switch of the relevant channel.

2.3.5. Y-Deflection

The Y-deflection coefficient can be set in ten calibrated steps by means of Y_A AMPLITUDE switch 805a and Y_B AMPLITUDE switch 805b.
In position ACx10 of ACx10/AC/DC switches 806a and 806b the gain is a factor then higher, but the bandwidth is reduced.
The trace can be shifted in vertical direction by means of Y_A and Y_B POSITION controls 602a and 602b.

2.3.6. X-Deflection

X-deflection is effected either internally by the time-base generator or externally by a voltage applied to X INPUT socket 852. X MAGN. control 601a allows a 5x magnification of the trace in X direction. The trace can be shifted in horizontal direction by means of X POSITION control 601b.

2.3.6.1. Time base

The X deflection coefficient can be set in 16 steps by means of TIME/cm switch 801.
TIME/cm control 609 allows a continuous control between the steps. The deflection coefficient is calibrated when X MAGN. control 601a is turned anti-clockwise to position x1 and TIME/cm control 609 clockwise to position CAL.

2.3.6.2. External X-deflection

The time-base generator is switched off when TIME/cm switch 801 is in one of the positions 5 V/cm and 1 V/cm. Then the X deflection is provided by an external signal applied to X INPUT socket 852.

3. Service data

3.1. CIRCUIT DESCRIPTION (FIG. 27)

3.1.1. Attenuators: Unit 1A and Unit 1B

Units 1A and 1B are identical.
The input signal can be applied either direct (DC) or via a blocking capacitor (AC) to attenuator 805a or 805b as dictated by ACx10/AC/DC switch 806a or 806b; in position ACx10 the input sensitivity is increased by a factor ten.
The attenuators consist of five sections which are, via Y_A AMPL. switch 805a and Y_B AMPL. switch 805b, interconnected in such a way that a total of ten deflection coefficients is obtained.
The attenuator sections are frequency compensated by trimmers 504, 508, 512, 517 and 521 so that the input impedance of 1 MΩ//30 pF sockets 853 and 854 is the same in all position of step attenuators 805a and 805b. The input capacitance is adjusted to the same value for all attenuator positions by means of trimmers 502, 506, 510 515 and 518.

3.1.2. Vertical amplifier: Unit 2

The oscilloscope comprises two identical vertical amplifiers, one for channel Y_A and one for channel Y_B, the former of which is described. The corresponding elements for channel Y_B are given in brackets.

3.1.2.1. Input stage

The input stage is equipped with a double triode 301 (351) and is connected so as to form a push-pull amplifier.
One system of the valve acts as an impedance converter (cathode follower) with a high input and a low output impedance, thus the next stage is voltage driven. Resistor 604 (654) protects the valve from too high an input voltage.
Diodes 407, 408 and 402 (457, 458 and 452) limit the output voltage of the cathode follower so as to protect the next stage. Normally these diodes are blocked.
The other system of the valve reduces the d.c. drift of the amplifier because variations of the d.c. levels on the cathodes of the push-pull amplifier cancel out.
A d.c. voltage is used for the heater supply of the valve.

3.1.2.2. Preamplifier

The preamplifier comprises three stages and will be discussed with the aid of the equivalent circuit shown in Fig. 6.

The first stage with transistors 311 and 312 (361 and 362) is a differential amplifier stage which balances the preamplifier. The large degree of negative feedback via resistor 611 (661) stabilises the gain and increases the output impedance of this stage. The transfer ratio (ratio of alternating output current and alternating input voltage) virtually equals the reciprocal value of the feedback resistor.
In position ACx10 of ACx10/AC/DC switch 807 (808) resistors 612 and 613 (662 and 663) shunt feedback resistor 611 (661) thus reducing its value by a factor of ten. Consequently, the gain of the stage increases by the same factor.

Basically, the first stage is a voltage-to-current converter. Its output current, which is proportional to the input signal, is applied to terminals 3 and 4 of the second stage.

Select-in-test resistor 638 (688) allows adjusting of the operating point of the first stage.

The second stage with transistors 313 and 314 (363) and (364) is an amplifier with negative shunt-feedback via resistors 616 and 618 (666 and 668). As a result of this feedback method, the in- and output impedance is low (virtually the reciprocal value of the mutual conductance of the transistor). As the input impedance is low and the stage is driven by a current, the voltage difference between terminals 3 and 4 is small. The magnitude of the amplified voltage across terminals 5 and 6 is chiefly determined by resistors 616 and 618 (666 and 668). The output voltage across terminals 5 and 6 causes feedback currents to flow through these resistors.
Consequently, the currents through terminals 3 and 4 are practically balanced. The base currents i_B are negligible in relation to the feedback currents. The second stage is basically a current-to-voltage converter.

The gain of the first two stages (between terminals 5-6 and 1-2) is 4x in positions AC and DC of ACx10/AC/DC switch 807 (808).
This gain is slightly lower than the theoretical value that can be found using the approximation formula:

$$\text{gain} = \frac{\text{feedback resistance 616 + 618}}{\text{feedback resistance 611}}$$

$$= \frac{12\ \text{k}\Omega + 12\ \text{k}\Omega}{5.1\ \text{k}\Omega} = 4.7$$

In position ACx10 of the ACx10/AC/DC switch, the gain is 40.

Capacitors 505 and 508 (555 and 558) and trimmer 509 (559) correct the frequency response at high frequencies. Y_A and Y_B POSITION potentiometers 602a and 602b allow a zero-line shift of approximately three times the screen height.

The third stage of the preamplifier comprises transistors 315 and 316 (365 and 366) and is basically a voltage-to-current converter like the first stage.

The overall gain of the preamplifier is adjusted by means of potentiometer 627 (677). Resistor 629 (679) and capacitor 510 (560) correct the frequency response.

3.1.2.3. Trigger pick-off stage

The triggering signal is obtained from the collector of transistor 314 (364) and applied to the trigger-pulse shaper via emitter follower 317 (367).
The emitter voltage of transistor 317 (367) and the input signal are in phase with one another.

3.1.2.4. Channel switch

The switch consisting of diodes 405 and 406 (455 and 456) connects the preamplifier output to the input of the final amplifier (terminals 7 and 8 in Fig. 6). The anode potential of these diodes is approximately +6.8 V. They are conductive and do not affect the collector currents of transistors 315 and 316 (365 and 366), as long as diodes 403 and 404 (453 and 454) are blocked. The latter diodes are blocked if their cathode potential is approximately 0 V.
Diodes 403 and 404 (453 and 454) are conductive if their cathode potential is about +9.5 V.
Then the collector currents of transistors 315 and 316 (365 and 366) are short-circuited and no signal reaches the final amplifier.
Diodes 403 and 404 (453 and 454) are driven by the output voltage of a flip-flop.

3.1.

3.1.

3.1.3. Horizontal amplifier: Unit 3 and Unit 3A

3.1.3.1. Input amplifier and attenuator

The input amplifier comprises transistors 301 and 302 and is used both as trigger amplifier and as X amplifier. Both stages are basically current-to-voltage converters the gain of which is chiefly determined by resistors 604/U3 and 610/U3. The second stage (transistor 302) is used as phase inverter. The collector voltages of transistors 301 and 302 are equal in amplitude and opposite in phase. The +/- switch 803 allows selection of one of these voltages thus enabling triggering on the positive- or negative-going edge of the signal. The amplitudes of the collector voltage are equalized by means of potentiometer 607/U3.

In the external triggering mode, transistor 301 is protected from overloads by resistor 601/U3 and diodes 401, 402, 403 and 404.
For external X deflection, transistor 301 is protected by resistor 601/U3A and the same diodes; resistor 602/U3A reduces the gain by a factor of five.

3.1.3.2. Peak detector and sync separator

The peak detector consists of a clamping circuit followed by a switching stage with transistor 304.

The clamping circuit comprises emitter follower 303, capacitor 503 and diode 405. The positive half-cycles of the triggering signal at the emitter of transistor 303 charge capacitor 503 via diode 405 to the peak value of the triggering signal.
As a result of this, the anode of diode 405 and, thus, the base of transistor 304 will attain a potential of approximately 0 V.
Via the leakage in capacitor 503, the reverse resistance of diode 405, the input impedance of transistor 304, and resistor 616/U3, capacitor 503 can be discharged a little. This result in a positive potential of approximately 1 V on the anode of diode 405 and the base of transistor 304 during the peaks of the triggering signal.
The switching stage is conductive when the base of transistor 304 is positive with respect to its emitter. The emitter is biased at -0.7 V by resistor 619/U3 and diode 406/U3, so that the transistor will be conductive during the positive peaks of the triggering signal. When transistor 304 is cut off, its collector voltage is determined by resistors 617/U3 and 618/U3. This voltage level lies above the hysteresis gap of the next Schmitt-trigger with transistors 305 and 306 (Fig. 8).

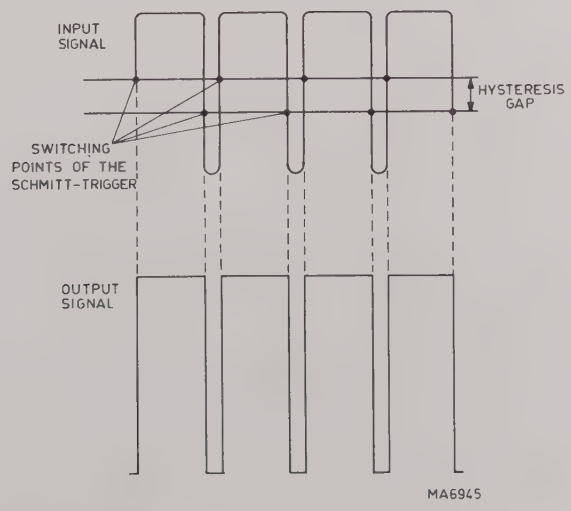


Fig. 8. Working of Schmitt-trigger 305-306

If the switching stage is conductive, the collector voltage of transistor 304 is approximately +1 V. This voltage level lies below the hysteresis gap of the Schmitt-trigger.

In position TV of NORM./TV/MAINS switch 802 the peak detector operates as sync separator. Then switching stage 304 is driven in such a way that it is only conductive during the peaks of the sync pulses. The frame and line sync pulses are separated by means of capacitors 505/U3 and 506/U3a, together with TIME/cm switch 801. In positions 0.2 ms to 50 ms of TIME/cm switch 801, triggering takes place on the frame sync pulses and in positions 0.5 μs to 0.1 ms on the line sync pulses. The TV position may also be useful when l.f. signals (up to approx. 17 kHz) are used for triggering, as possible h.f. interferences are suppressed by capacitor 505/U3.

In position NORM. of NORM./TV/MAINS switch 802 the maximum bandwidth of the stage is available; it is, therefore, important to set the switch to this position when h.f. signals are used for triggering.

In position MAINS of NORM./TV/MAINS switch 802 transistor 304 is cut off and Schmitt-trigger 305-306 is, via voltage divider 622/623/U3, driven by a signal with the mains frequency.

3.1.3.3. Trigger-pulse shaper

The Schmitt-trigger with transistors 305 and 306 (Fig. 8) is a trigger pulse shaper which supplies trigger pulses with the same frequency as the input signal. Emitter follower 307 matches the output of the Schmitt-trigger and the high load by the auto-circuit.

3.1.3.4. Time-base generator and hold-off circuit

The time-base generator comprises constant-current source 311-312 driven by sweep-gating multivibrator 309-310. For the explanation of the circuit we start with the following condition of the sweep-gating multivibrator: transistor 309 cut off, transistor 310 conductive. Then the collector voltage of transistor 310 is approximately +7 V.
As the Zener voltage of diode 409 (appr. 7.2 V) and the collector voltage of 310 are of opposite polarity, the base voltage of transistor 312 is slightly negative so that this transistor is cut off.
As long as transistor 312 remains cut off, current source 311 charges capacitor 514 and, dependent on the position of TIME/cm switch 801, either capacitor 501 or 502 with a constant current.
This results in a linearly increasing voltage across these capacitors. This sawtooth voltage is available on the emitters of emitter followers 313 and 314. The emitter voltage of transistor 313 is applied to the horizontal amplifier, via TIME/cm switch 801. The emitter voltage of transistor 314 is fed back to sweep-gating multivibrator 309-310, via resistor 638/U3.
If the sawtooth voltage has reached a certain level, the sweep-gating multivibrator switches over to the condition: transistor 309 conductive, transistor 310 cut off. Then the collector voltage of transistor 310 is approximately +12 V. The difference between this voltage and the zener voltage of diode 409 is about 4.5 V. Consequently, the base potential of transistor 312 becomes so positive that the transistor is hard on, and the fly-back takes place.

As long as transistor 312 is conductive, the time-base capacitors are discharged via this transistor. Upon arrival of a negative pulse on the base of transistor 309, the sweep-gating multivibrator switches over to condition: transistor 309 cut off, transistor 310 conductive.

The feedback circuit also comprises the hold-off capacitors 503/U3, 504/U3 and 512/U3 which prevent starting of the time-base generator before the time-base capacitors have been entirely discharged.
Potentiometers 647/U3 and 648/U3 allow adjustment of the time coefficients in the ranges 50 ms/cm to 1 ms/cm and 0.5 ms/cm to 0.5 μs/cm.

The magnitude of the charging current of the time-base capacitors and, thus, the time-coefficient is determined by resistors 603/U3A to 608/U3A. Continuous control of the charging current is possible with the TIME/cm control 609/U3A.

3.1.3.5. Trigger auto-circuit

In the absence of a triggering signal transistor 304 is continuously conductive. Then the collector voltage of this transistor drives pulse shaper 305-306 in such a way that transistor 305 is cut off and 306 is conductive. The collector voltage of transistor 306 is then approximately 6 V. Capacitor 508/U3 is charged to this potential via emitter follower 307 and diode 407. Consequently, the average d.c. base potential of emitter follower 308 drops from 11 V (when the time-base is not free-running) to 6 V. This results in a drop of the average d.c. base level of transistor 309 in the sweep-gating multivibrator 309-310.
The sawtooth voltage which is fed back via transistor 314 and superimposed on this level can now exceed both limits of the hysteresis gap of transistor 309. The time-base generator is then free-running, i.e. the described cycle is repeated periodically.

N.T.C. Resistor 634 stabilises the temperature of voltage divider 631-632-633-635/U3.

The d.c. level of the trigger auto-circuit can be adjusted with potentiometer 632/U3.

3.1.3.6. X Output stage

The working of the X output amplifier is basically identical to that of the Y amplifier.
Transistor 317 acts as a constant-current source in the emitter circuit of transistors 315 and 316. These transistors form a differential amplifier, one input of which is driven by the sawtooth generator. The other input is driven by a d.c. voltage from X POSITION potentiometer 601b, allowing trace shift in horizontal direction.

The gain of the differential amplifier can be preset by potentiometer 659/U3; continuous control is possible with X MAGN. potentiometer 601a.

The voltage gain is obtained by means of the cascode circuits 318-320 and 319-321.
Resistors 662, 663, 669, 679 and 680/U3 stabilise and couple the amplifier stages.

3.1.3.7. Chopper multivibrator

The chopper multivibrator is an astable, emitter-coupled multivibrator comprising transistors 322/U3 and 323/U3. The marking and spacing intervals of the generated signal differ strongly and are chiefly determined by the unequal emitter resistances. The frequency of the signal is approximately 400 kHz.

3.1.3.8. Blanking stage

The blanking stage suppresses the electron beam during the flyback of the sawtooth and during the switching from channel Y_A to channel Y_B in the chopped mode. The stage comprises transistors 326/U3 and 327/U3 in cascode arrangement.
Via coupling diodes 412/U3 and 413/U3, the blanking stage is driven by either the time-base generator or the chopper multivibrator. This depends on the position of TIME/cm switch 801.

The blanking stage supplies a positive voltage of approximately 100 V with negative-going pulses of a large amplitude. Capacitor 513/U4 blocks the d.c. component of this signal. Diodes 405/U4 and 406/U4 suppress the positive pulses, so that the Wehnelt cylinder receives only negative pulses. The c.r.t. is cut off during the time that the Wehnelt cylinder is kept at a negative potential by these pulses.

3.1.3.9. Square-wave generator

The square-wave generator is an astable emitter-coupled multivibrator comprising transistors 328/U3 and 329/U3. The generated signal has a mark-to-space ratio of 1 : 1 and a frequency of approximately 2 kHz. Diode 415 clips the signal so as to obtain a well-defined square wave of approximately 5 V_{p-p}.

3.1.4. Power supply: Unit 4

3.1.4.1. Unstabilised d.c. voltages

Rectifier 412 supplies the voltage for the Y output amplifier and the blanking stage (voltage C). The voltage doubler with diodes 411 and 413 and capacitors 524 and 525 supplies the voltage for the X output amplifier (voltage B) and also, via resistor 618 (voltage A) the Y and X input stages.

Rectifier 410 supplies a positive and a negative voltage for the heater supply of the Y input valves. The use of d.c. voltages prevents hum phenomena.

3.1.4.2. Stabilised high-voltage supply

The d.c. converter is a controlled sine-wave oscillator with voltage tripler. The oscillator circuit formed by coil 751 and capacitors 501, 502 and 503 is connected between emitter and collector of transistor 303. The a.c. voltage generated in oscillator coil 751 is approximately 700 V at a frequency of approximately 50 kHz.
This voltage is rectified and trebled by diodes 402, 403 and 404 and capacitors 505, 506 and 507, and smoothed by RC filter 607-510.

The control voltages for the intensity of the electron beam and its focussing are taken off from the voltage divider with resistors 608, 603, 610, 604, 611, 612, 613 and 614.

The control ranges of potentiometers INTENS 603 and FOCUS 604 are determined by potentiometer 608/U4.
The driving voltage for the control amplifier with transistors 301 and 302 is adjusted with potentiometer 613. Diode 401 acts as reference source. The ripple component of the output voltage is fed back via the capacitive voltage divider with capacitors 507 and 508. This gives an extra driving signal for the control amplifier so that the high voltage is additionaly smoothed and stabilised.

Diodes 405 and 406 suppress the positive pulses of the blanking signal.

3.2. DISMANTLING

IMPORTANT - In this instrument very high voltages are generated so that you must take due care when you are working on the interior of the instrument.
- Switch off the instrument at least one minute before you start replacing parts.

3.2.1. Removing top cover and handle

- Remove the two screws at either side of the instrument
- Lift off the cover

The handle has been fitted to the cover with a screw and nut at either end of the handle bracket.

3.2.2. Removing the bottom plate

- Remove the four screws on the bottom plate
- Lift off the bottom plate

3.2.3. Removing the knobs

3.2.3.1. Single knobs

The knobs can be pulled off the shaft.

3.2.3.2. Double knobs (Fig. 9)

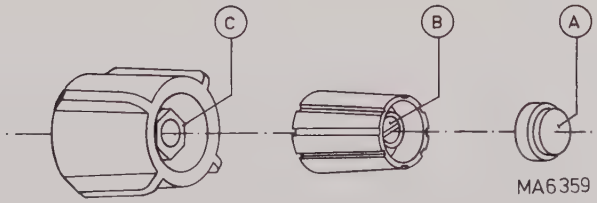


Fig. 9. Removing the knobs

- Remove cap A
- Slacken screw B
- Pull the inner knob off the shaft
- Slacken nut C
- Pull the outer knob off the shaft

3.2.4. Removing bezel and measuring graticule

The bezel can be pulled off after slightly pressing its long sides together. Subsequently, the contrast filter and the measuring graticule can be removed.

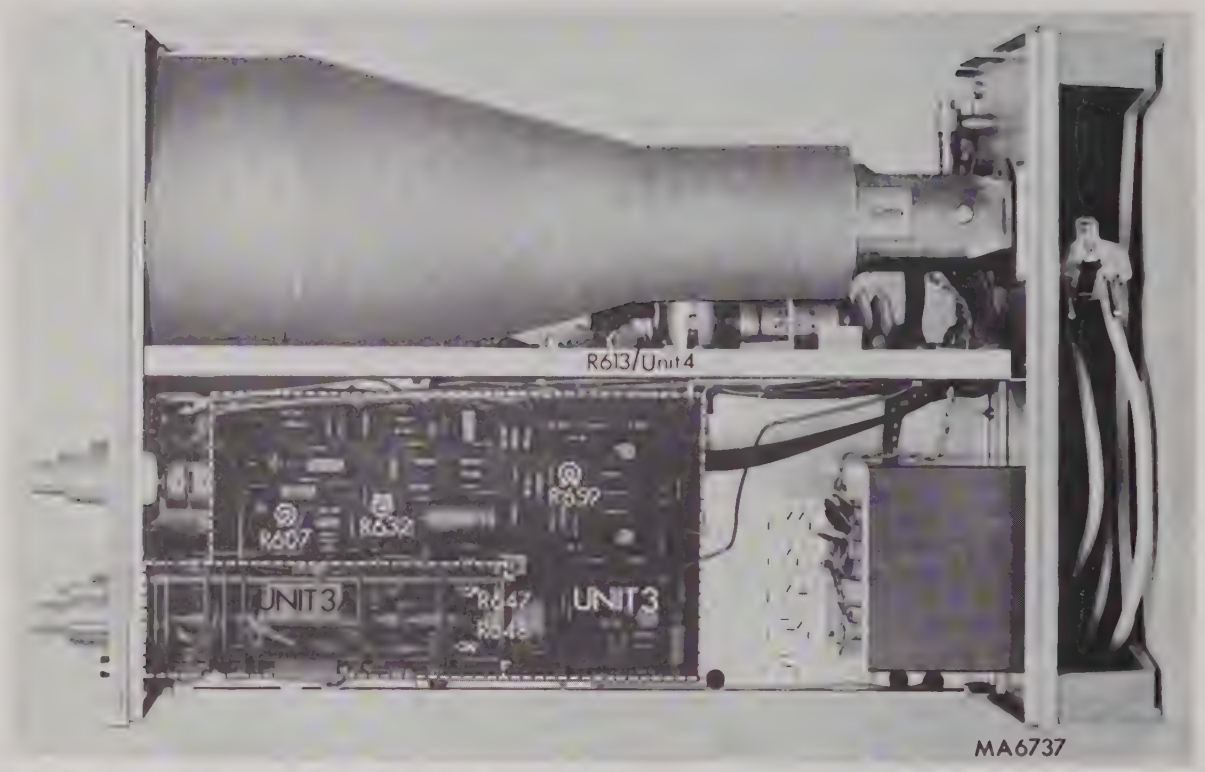


Fig. 10. Adjusting elements on Units 3 and 4

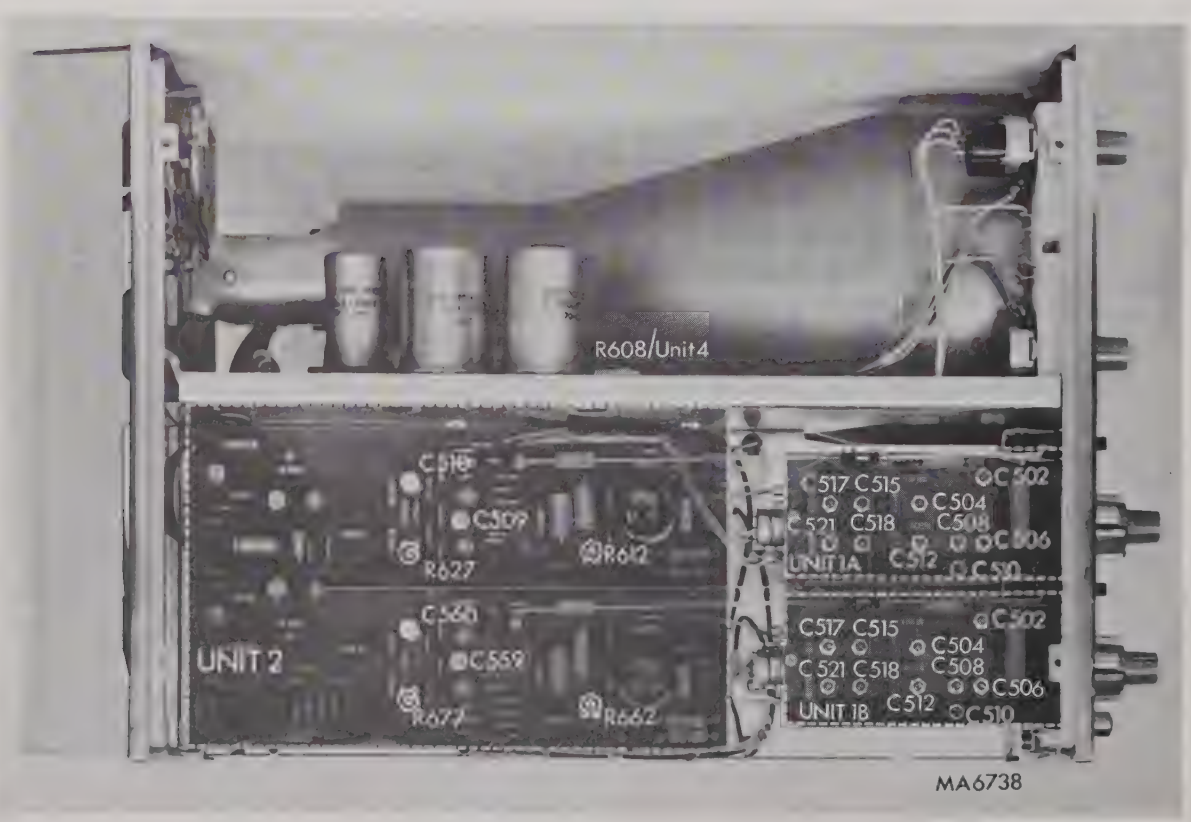


Fig. 11. Adjusting elements on Units 1A, 1B, 2 and 4

3.3. ADJUSTING ELEMENTS AND THEIR FUNCTIONS

Adjusting element	Section	Adjustment	Fig.
Potentiometer 613/U4	3.4.2.	C.r.t.	10
Potentiometer 608/U4	3.4.2.	C.r.t.	11
Potentiometer 607/U3	3.4.3.2.	Gain	10
Potentiometer 659/U3	3.4.3.2.	X Magnification	10
Potentiometer 632/U3	3.4.3.3.	Stability	10
Potentiometer 647/U3	3.4.3.4.	Time base	10
Potentiometer 648/U3	3.4.3.4.	Time base	10
Potentiometer 627/U2 (667/U2)	3.4.5.2.	Y Gain	11
Trimmer 509/U2, 510/U2	3.4.5.3.	Frequency response	11
559/U2, 560/U2)			
Resistor 638/U2 (688/U2)	3.4.5.4.	Y Position	11
Potentiometer 612/U2	3.4.5.5.	ACx10	11
Trimmer 517/U1A(B)	3.4.5.6.	Attenuator	11
515/U1A(B)			
521/U1A(B)			
518/U1A(B)			
504/U1A(B)			
502/U1A(B)			
508/U1A(B)			
506/U1A(B)			
512/U1A(B)			
510/U1A(B)			

3.4. CHECKING AND ADJUSTING

The tolerances given in the following text apply to newly adjusted instruments only. Therefore, they may differ from the values stated in chapter 1.2.

All adjusting elements are tabulated together with their functions and positions in chapter 3.3.

3.4.1. Power supply (Unit 4)

- Connect the instrument to the mains via an ammeter (moving-iron instrument)
- Check that the mains current is approximately 220 mA at a mains voltage of 220 V.
- Check the d.c. and hum voltages in accordance with the following table:

Contacts	Nominal value	Tolerance	Hum voltage
3-1	+150 V	$\pm$ 2 %	$\leq$ 0.3 V_{p-p}
4-1	+140 V	$\pm$ 2 %	$\leq$ 3 V_{p-p}
7-1	+440 V	$\pm$ 2 %	$\leq$ 10 V_{p-p}
8-1	-18.6 V	$\pm$ 2 %	$\leq$ 1.5 V_{p-p}
11-1	+18.6 V	$\pm$ 2 %	$\leq$ 1.5 V_{p-p}
12-1	-15.2 V	$\pm$ 3 %	$\leq$ 0.12 V_{p-p}
13-1	+14.7 V	$\pm$ 3 %	$\leq$ 0.12 V_{p-p}

3.4.2. Cathode-ray tube (310)

- Display a time-base line using INTENS. potentiometer 603.
- Check that the voltage between contact U4/16 and earth ($\perp$) is -2.0 kV (use a d.c. voltmeter with an internal resistance > 50 MΩ). If necessary readjust potentiometer 613/U4.
- Lower the mains voltage by 15 %.
- Focus the beam with FOCUS potentiometer 604.
- Set INTENS. potentiometer 603 for maximum intensity
- Adjust potentiometer 608/U4 in such a way that the voltage at contact U4/14 just fails to be affected (< 1 %).
- Check that the trace runs parallel to the graticule. If necessary, slacken the collet and turn the c.r.t. to the correct position.
- Readjust the mains voltage to its nominal value.
- Check that the zero line does not drift more than 2 mm per hour after warming up.

3.4.3. X Adjustment (Unit 3)

3.4.3.1. Checking the operating point of the output stage

- Interconnect contacts U3/15 and U3/16 by means of two series-connected 100 kΩ resistors.
- Check that the voltage at the centre tap is +143 V $\pm$ 10 % (use a d.c. voltmeter with an internal resistance $\geq$ 100 MΩ).

3.4.3.2. Gain and X MAGN.

- Apply a sawtooth voltage to Y_A input socket 853.
- Apply a $\frac{1}{2}$T square-wave voltage of 1.6 V_{p-p}, frequency 2 kHz, to X input socket 852.
- Set TIME/cm switch 801 to position 1 V/cm.
- Set X MAGN. potentiometer 601a to position x5.
- Check that the trace width is 8 cm. If necessary, readjust potentiometer 607/U3.

- Increase the square-wave voltage to 8 V_{p-p}.
- Set TIME/cm switch 801 to position 5 V/cm.
- Check that the trace width is 8 cm ± 4 %.
- Set TIME/cm switch 801 to position 1 V/cm
- Set X MAGN. potentiometer 601a to position x1.
- Check that the trace width is 8 cm. If necessary, readjust potentiometer 659/U3.
- Remove the input voltages

3.4.3.3. Stability

- Set TIME/cm switch 801 to position 10 µs/cm
- Set NORM./TV/MAINS switch 802 to position NORM.
- Set +/- switch 803 to position +.
- Set Y_A/Y_B/EXT. switch 804 to position EXT.
- Set TIME/cm potentiometer 609 to position CAL.
- Set X MAGN. potentiometer 601a to position x1.
- Apply a sine-wave voltage of 10 V_{p-p}, frequency 1 kHz, to X input socket 852.
- Connect the negative terminal of a floating 2.5 V d.c. voltage source to Y_A input socket 853 and the positive terminal to contact U3/35.
- Set Y_A AMPLITUDE switch 805a to position 0.1 V/cm.
- Turn potentiometer 632/U3 fully clockwise
- Shift the starting point of the displayed line onto the vertical centre axis by means of X POSITION potentiometer 601b.
- Shift the line to 2 cm below the horizontal centre axis by means of Y_A POSITION potentiometer 602a.
- Turn potentiometer 632/U3 anti-clockwise until the horizontal deflection ceases. Check that a light spot appears on the vertical centre axis.
  The spot must lie approximately 0.2 V above the starting point of the line as earlier adjusted.
- Turn potentiometer 632/U3 clockwise until the reappearing line is displayed exactly midway between the limit values earlier determined.
- Remove the voltage sources.

3.4.3.4. Time base and X POSITION

- Set X MAGN. potentiometer 601a to position x1.
- Set TIME/cm potentiometer 609 to position CAL.
- Apply needle pulses to Y_A input socket 853.

  Pulse interval : equal to the time coefficient set with TIME/cm switch 801
  Frequency error : << 1 %
  Amplitude : equivalent to 4 cm trace height
- Check that the length of the time-base line is ≥ 10 cm in all the time positions of the TIME/cm switch.
- Align the pulses with the graticule lines by means of X POSITION potentiometer 601b.
- Set TIME/cm switch 801 to position 5 ms/cm.
- Check that the 8 centre periods have a total width of 8 cm. If necessary, readjust potentiometer 647/U3.
- Set TIME/cm switch 801 to position 20 µs/cm.
- Check that the 8 centre periods have a total width of 8 cm. If necessary, readjust potentiometer 648/U3.
- Check the error of the time coefficients in the other positions of TIME/cm switch 801:
  < 3 % within ± 4 cm on the X axis
  ≤ 5 % at the edge of the screen

- Check that the control range of TIME/cm potentiometer 609 is at least 1 : 2.5
- Turn X POSITION potentiometer 601b fully both ways. It must be possible for both the start and the end of a 10 cm wide trace to be shifted to as far as the centre of the graticule. Tolerance: ± 5 mm.
- Remove the input signal

3.4.4. Triggering

- Apply a video signal of 625 lines (or, on French standard, 819 lines) to Y_A input socket 853. Trace height of the synchronising pulses: 1 cm.
- Set NORM./TV/MAINS switch 802 to position TV.
- Set +/- switch 803 to position + when the video signal is negative and to position - when it is positive.
- Check that the time-base generator is triggered by the line-synchronising pulses in positions 0.1 ms/cm to 0.5 µs/cm of TIME/cm switch 801, and by the frame-synchronising pulses in positions 50 ms/cm to 2 ms/cm.
- Apply a sine-wave voltage with the mains frequency to Y_A input socket 853. Adjust for a trace height of 2 cm.
- Apply a sine-wave voltage of 6 V with the mains frequency to TRIGG. socket 852.
- Set NORM./TV/MAINS switch 802 to position NORM.
- Set Y_A/Y_B/EXT. switch 804 to position Y_A.
- Check that there is a stationary display of a sine-wave voltage with the mains frequency.
- Set Y_A/Y_B/EXT. switch 804 to position Y_B.
- Check that there is a zero line displayed (delayed).
- Apply the input voltage from the Y_A input socket 853 to Y_B socket 854.
- Check that there is a stationary display of a sine-wave voltage with the mains frequency.
- Set Y_A/Y_B/EXT. switch 804 to position EXT.
- Check that there is a stationary display of a sine-wave voltage with the mains frequency.
- Set +/- switch 803 to position +.
- Check that the trace starts with a positive-going slope.
- Set NORM./TV/MAINS switch 802 to position MAINS.
- Check that there is a stationary display of a sine-wave voltage with the mains frequency.
- Remove the input signals.
- Apply a sine-wave voltage with a frequency of 10 Hz to Y_A input socket 853. Adjust for a trace height of 1 cm.
- Set Y_A/Y_B/EXT. switch 804 to position Y_A.
- Set NORM./TV/MAINS switch 802 to position NORM.
- Check that there is a stationary display of a sine-wave voltage with a frequency of 10 Hz.
- Increase the frequency of the input signal to 10 MHz. Adjust for a trace height of 3 cm.
- Check that there is a stationary display of a sine-wave voltage of 10 MHz.
- Remove the input signal.

.4.5. Y Amplifier, channel A (B) (Unit 2)

4.5.1. Checking the operating point of the output stage

- Check that the voltage between contact U2/13 and earth (⊥) is +74 V ± 10 % (use a d.c. voltmeter with an internal resistance ≥ 100 MΩ).

3.4.5.2. Y Gain

- Set ACx10/AC/DC switch 807 (808) to position DC,
- Set Y_A (Y_B) AMPLITUDE switch 805a (805b) to position 0.05 V/cm.
- Apply a square-wave voltage of 300 mV_{p-p}, frequency 2 kHz, rise time 300 ns, to Y_A (Y_B) input socket 853 (854).
- Check that the trace height is 6 cm. If necessary, readjust potentiometer 627/U2 (677/U2).
- Check that the deviation of the Y gain at mains voltage fluctuations of -15 % and +10 % is less than 1 % in positions DC and AC of ACx10/AC/DC switch 806a (806b), and less than 3 % in position ACx10.
- Readjust the mains voltage to its nominal value.

3.4.5.3. Frequency response

- Apply a square-wave voltage of 300 mV_{p-p}, frequency 1 MHz, rise time between 10 and 50 ns, to Y_A (Y_B) input socket 853 (854).
- Adjust trimmer 509/U2 (559/U2) and 510/U2 (560/U2) for optimum square-wave response. Maximum permissible overshoot: 2 %.
- Apply a sine-wave voltage of 400 mV_{p-p}, frequency 10 MHz to Y_A (Y_B) input socket 853 (854).
- Check that the trace height is at least 5.6 cm.

3.4.5.4. Y POSITION

- Apply a sine-wave voltage of 1.2 V_{p-p}, frequency 1 MHz, to Y_A (Y_B) input socket 853 (854)
- Turn Y_A (Y_B) POSITION potentiometers 602a (602b) fully both ways and check that the peaks of the signal can be displayed without distortion within the measuring graticule. If necessary, select a different value for resistor 638/U2 (688/U2).
- Remove the input voltage.

3.4.5.5. ACx10 Adjustment, hum voltages

- Set ACx10/AC/DC switch 807 (808) to position ACx10.
- Set Y_A (Y_B) AMPLITUDE 805a (805b) to position 0.05 V/cm.
- Apply a square-wave voltage of 30 mV_{p-p}, frequency 2 kHz, rise time 300 ns, to Y_A (Y_B) input socket 853 (854).
- Check that the trace height is 6 cm. If necessary, readjust potentiometer 612/U2 (662/U2).
- Decrease the frequency of the input signal to 10 Hz.
- Check the lower frequency limit by means of a droop test. The frequency limit should be lower than 2.5 Hz which corresponds to a droop of less than 46 % with respect to the peak value.
- Remove the input signal.
- Check that the deflection due to hum does not exceed 2 mm (peak-to-peak).

3.4.5.6. Attenuator (Units 1A and 1B)

- To equalize the input capacitance in all positions of the Y_A (Y_B) AMPLITUDE switch 805a (805b), an input RC standardizer is connected in series with Y_A (Y_B) input socket 853 (854). The input RC standardizer consists of the parallel circuit of a 1 MΩ resistor and a 3-60 pF trimmer (Fig. 12) and is adjusted as indicated in the following table.
- Connect a square-wave generator (rise time 100 ns, internal resistance < 1 kΩ) to Y_A (Y_B) input socket 853 (854). Adjust amplitude and frequency in accordance with the following table.
- Adjust the trimmers mentioned in the table for optimum square-wave response.

Y_A (Y_B) AMPLITUDE switch 805a (805b) to position	ACx10/AC/DC switch 806a (806b) to	Generator e.m.f.	Generator frequency (r.t. 100 ns)	Use input RC standardizer	Trimmer on UNIT 1A (1B) to be adjusted	
0 V/cm	AC	600 mV	10 kHz	no	517	square-wave response
0.2 V/cm	AC	1.2 V	10 kHz	no	521	
0.5 V/cm	AC	3 V	10 kHz	no	504	
1 V/cm	AC	6 V	10 kHz	no	515	
2 V/cm	AC	12 V	10 kHz	no	518	
5 V/cm	AC	30 V	10 kHz	no	508	
50 V/cm	ACx10	30 V	10 kHz	no	512	
0.1 V/cm	AC	1.2 V	2 kHz	yes	trimmer in standardizer	
0.5 V/cm	AC	6 V	2 kHz	yes	502	input capacit.
5 V/cm	ACx10	6 V	2 kHz	yes	506	
50 V/cm	ACx10	60 V	2 kHz	yes	510	

- Remove input voltage.

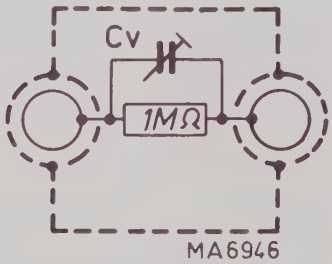


Fig. 12. Input RC standardizer

3.4.5.7. Cross talk

- Set ACx10/AC/DC switches 806a and 806b to position DC.
- Set Y_A and Y_B AMPLITUDE switches 805a and 805b to position 0.05 V/cm.
- Apply a sine-wave voltage of 0.8 V_{p-p}, frequency 10 MHz, to Y_A input socket 853.
- Check that the trace height on channel B due to cross talk does not exceed 0.2 cm (p-p).
- Connect the input signal to Y_B input socket 854.
- Check that the trace height on channel A due to cross talk does not exceed 0.2 cm (p-p).
- Increase the input voltage to 1.6 V_{p-p}.
- Decrease the frequency of the input signal to 1 MHz.
- Check that the trace height on channel A due to cross talk does not exceed 0.8 cm (p-p),
- Connect the input signal to Y_A input socket 853.
- Check that the trace height on channel B due to cross talk does not exceed 0.8 cm (p-p).

3.4.6. PROBE ADJ.

- Set ACx10/AC/DC switch 806a to position AC.
- Set Y_A AMPLITUDE switch 805a to position 1 V/cm.
- Apply the voltage of PROBE ADJ. socket 851 to Y_A input socket 853 with the aid of a 1:1 probe.
- Check that the trace height is 5 cm $\pm$ 10 % and that the frequency of the displayed waveform is 2 kHz $\pm$ 15 %.

3.4.7. AC/DC Mode

- Set Y_A and Y_B AMPLITUDE switches 805a and 805b to position 0.05 mV/cm.
- Apply a 500 V d.c. voltage to Y_A and Y_B input sockets 853 and 854.
- Set ACx10/AC/DC switches 806a and 806b from position DC to position AC.
- Check that the d.c. voltage is disconnected.
- Remove the input voltages.

3.4.8. Y POSITION and Y OFF switch

- Set Y_A POSITION potentiometer 602a to position Y_A OFF.
- Check that the channel A trace disappears.
- Set Y_B POSITION potentiometer 602b to position Y_B OFF.
- Check that the channel B trace disappears.

3.5. REPLACING COMPONENTS

The opening of parts or removal of covers is likely to expose live conductors. The instrument should, therefore, be disconnected from all voltage sources before any opening of parts or removal of covers is started.

During and after dismantling, bear in mind that capacitors in the instrument may still be charged, even if it has been separated from all voltage sources.

After replacing components it may be necessary to readjust the relevant circuit in accordance with chapter 3.4. CHECKING AND ADJUSTING.

3.5.1. Replacing the fuse

Thermal fuse 880 is fitted on top of the mains transformer. After unsoldering both connection wires, the fuse can be pulled out of the transformer.
The fuse can be replaced without removing the transformer from the instrument.

3.5.2. Replacing ECC83 valves 301/U2 and 351/U2

Replacement valves should be aged for 100 hours at an anode voltage of 140 V and an anode current of 1 mA.

3.6. INFORMATION FOR ASSISTENCE IN FAULT FINDING

3.6.1. Mains transformer 752

The winding data and the open output voltages of the mains transformer have been indicated in a table in circuit diagram Fig. 27.

3.6.2. Voltage levels and waveforms

The d.c. voltage levels in circuit diagram Fig. 27 have been measured with a PHILIPS Multimeter P817.
During the measurements no signal was applied to the input sockets Y_A and Y_B, and X MAGN. potentiometer 601a was set to position x1.

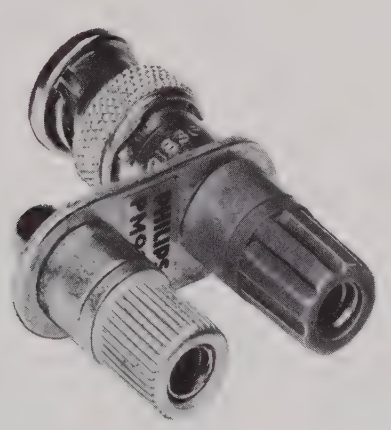
The waveforms have been recorded under the following conditions:
- NORM./TV/MAINS switch 804 to position NORM.
- +/- Switch 803 to position +.
- Y_A/Y_B/EXT. switch 804 to position Y_B.
- X MAGN. potentiometer 601a to position x1.
- TIME/cm potentiometer 609 to position CAL.
- Y_A and Y_B POSITION potentiometers 602a and 602b to mid position
- ACx10/AC/DC switches 806a and 806b to position AC.
- Y_B AMPLITUDE switch 805b to position 1 V/cm.
- TIME/cm switch 801 to position 0.1 ms/cm, with the exception of waveform ⑧ at the chopper multivibrator output (collector of transistor 323/U3) which has been measured with TIME/cm switch 801 set to position 0.2 ms/cm.
- A sine-wave voltage of 6 V_{p-p}, frequency 2 kHz, applied to Y_B input socket 854.

NOTE: All indicated voltage values should be regarded as typical values.

3.7. INFORMATION CONCERNING ACCESSORIES

3.7.1. Adapter PM 9051 (Fig. 13)

This is an adapter to make a BNC socket suitable for connection of two 4mm plugs.



MA 6369

Fig. 13. Adapter PM 9051

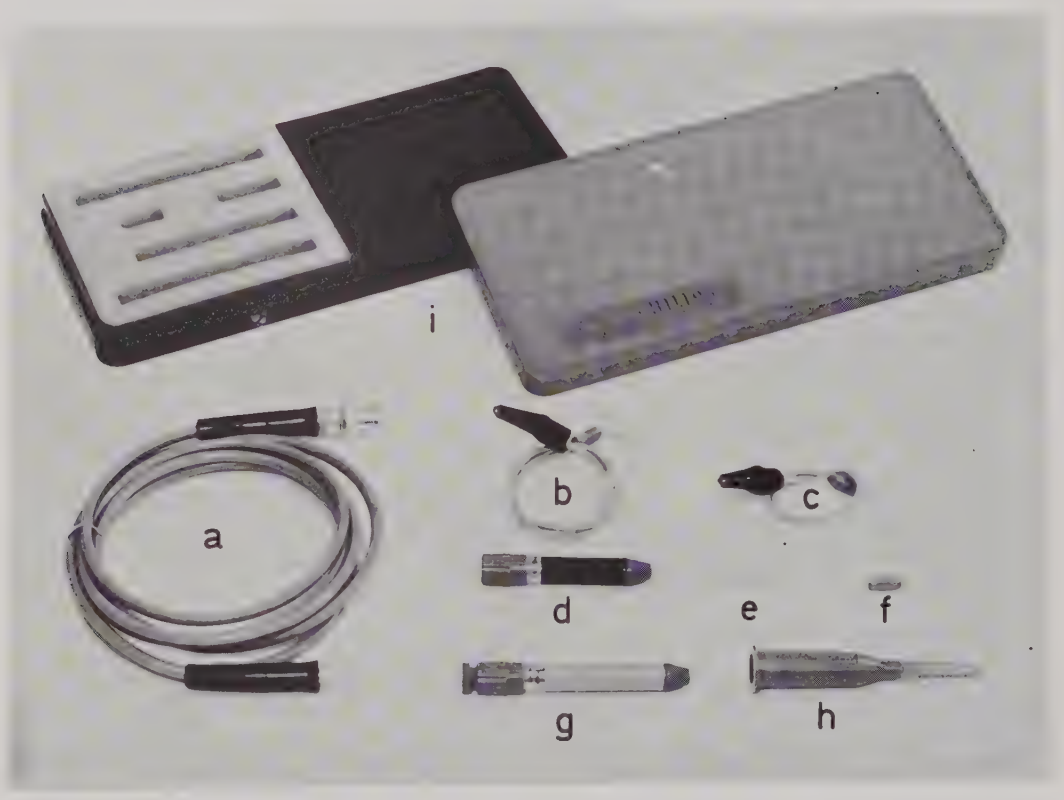
3.7.2. Attenuator probe sets PM 9326 and PM 9327 (Fig. 14)

These passive probe sets are equal but for the length of the probe cable which is 1.15 m for the PM 9326 and 2 m for the PM 9327.

NOTE: The measuring probe and the earth lead can be simply pulled from the cable.
The test clip, 4mm plug and test hook are screwed onto the measuring probe.

The sets consist of:

1 probe cable	Fig. 14a
1 earth lead 15 cm	Fig. 14b
1 earth lead 30 cm	Fig. 14c
1 probe 1:1 (black)	Fig. 14d
1 test pin	Fig. 14e
1 test hook	Fig. 14f
1 probe 1:10 (grey)	Fig. 14g
1 test clip	Fig. 14h
1 box	Fig. 14i



MA 6370

Fig. 14. Probe set

3.7.2.1. Technical data

Attenuation	10x ± 3 %
Input impedance	10 MΩ//8 pF
Max. permissible input voltage	1.000 V_{p-p}
Max. d.c. component with the blocking capacitor in the circuit	500 V

3.7.2.2. Adjustment (Fig. 15)

- Unscrew the probe locking nut be turning it anti-clockwise
- Rotate the probe body to change capacitance while watching display for desired waveform.
- When compensation is completed, carefully turn the locking nut clockwise, to lock it without disturbing the adjustment.

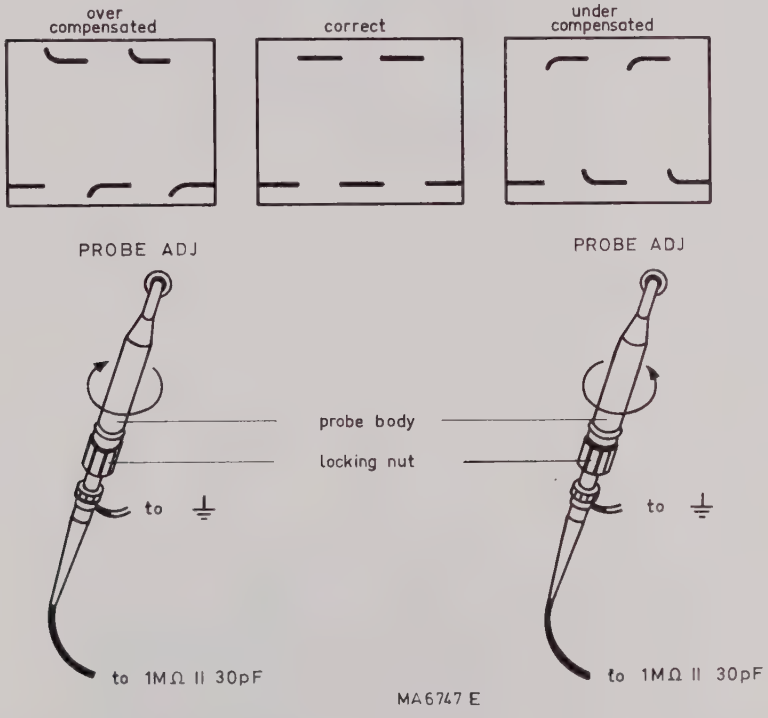


Fig. 15. Adjusting the attenuator probe

NOTE: The attenuator probe may cause distortion if it is not correctly adjusted.

3.7.3. Viewing hood PM 9366 (Fig. 16)

This hood shields the tube face from external light when the intensity of the light produced by the oscilloscope screen is low e.g. when observing phenomena with a low repetition frequency and a short rise time.

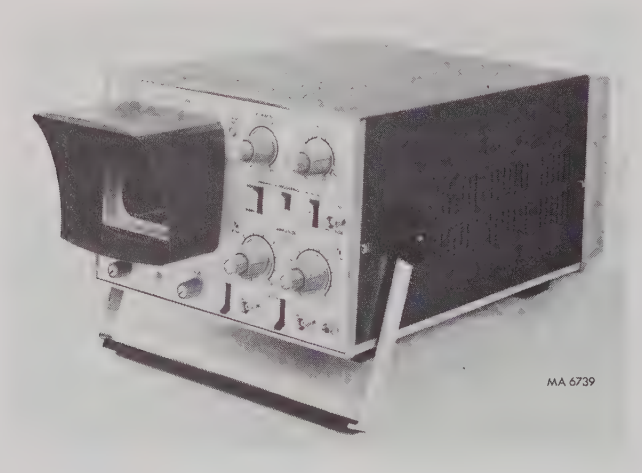


Fig. 16. Viewing hood

3.7.4. Multi-purpose camera PM 9380 (Fig. 17)

Camera PM 9380 has been designed to photograph oscilloscope displays in a quick and simple way. It incorporates the Polaroid instant photographic proces which has the advantage that you can see the picture only a few moments after you took it.

The PM 9380 comprises:
- a camera body
- a lens unit
- a carrying case
- a manual

Fig. 17. Multi-purpose camera PM 9380

3.7.5. Adapter PM 9377 (Fig. 18)

This adapter forms the connection between camera PM 9380 and oscilloscope PM 3110. The dimensions of the adapter are such, that the camera is automatically focussed when the camera-adapter combination is held against the oscilloscope.

NOTE: Together with this adapter, supplementary lens PM 9373 must be used.

Fig. 18. Camera adapter PM 9377

3.8. PARTS LIST

3.8.1. Mechanical parts (including a few electrical parts)

Item	Fig.	Qty	Order number	Description
1	19	1	5322 455 80061	Text plate
2	19	1	5322 498 40323	Handle, complete
3	19	1	5322 268 10031	Contact plug
4	19	1	5322 325 80058	Grommet
5	19	1	5322 413 40211	Knob 23 mm dia., shaft 6 mm dia.
6	19	4	5322 413 30085	Knob 14.5 mm dia., shaft 4 mm dia.
7	19	3	5322 413 40112	Knob 23 mm dia., shaft 6 mm dia.
8	19	4	5322 413 70039	Cover for knob (red)
9	19	5	5322 411 50258	Switch lever
10	19	1	5322 267 10004	BNC socket
11	19	1	5322 268 20051	Earth terminal
12	19	2	5322 267 10004	BNC socket
13	19	2	5322 413 30346	Knob 14.5 mm dia., shaft 6 mm dia.
14	19	2	5322 413 70038	Cover for knob (black)
15	19	1	5322 381 10116	Lens
16	19	4	5322 462 40201	Foot
17	19	2	5322 498 70043	Cover for handle
18	19	1	5322 450 60088	Measuring graticule
19	19	1	5322 480 30096	Contrast filter
20	19	1	5322 450 70033	Bezel
21	22	1	5322 290 60187	Terminal strip
22	20	1	5322 462 70826	Mains cable container
23	20	14	5322 255 40006	Transistor spacer TO5
24	20	2	5322 255 40053	Heat sink (for BF179)
25	20	1	5322 255 40073	Transistor spacer TO18
26	20	3	5322 277 30516	Slide switch (802, 803, 804)
27	20	1	5322 492 40377	Spring
28	22	6	5322 404 50375	Printed-wiring board clamp
29	22	2	5322 492 40392	Spring
30	22	4	5322 277 30411	Slide switch (806a, 806b, 807, 808)
31	22	2	4822 255 70139	Valve support (for ECC83)
32	20-22	5	5322 255 40054	Heat sink (for BFY50, BF178)
33	21	1	5322 255 70159	Valve support (for D13-480GH)
34	21	1	5322 466 60607	Rubber sleeve
35	20	1	5322 131 20036	C.R.T. Type D13-480GH
36	20	1	5322 321 10073	Mains cable
37	20-10	1	5322 216 50215	Unit 3, complete
38	20-10	1	5322 105 30067	Unit 3A, complete
39	20	1	5322 146 34013	Mains transformer (752)
40	20	1	5322 252 20001	Thermal fuse
41	22	2	5322 131 80018	Valve ECC83
42	22	1	5322 134 20102	Neon tube
43	22-11	2	5322 105 30066	Unit 1A (B), complete
44	22-11	1	5322 216 50213	Unit 2, complete
45	21	1	5322 158 20341	Coil (751)
46	21	1	5322 216 50214	Unit 4, complete
47	20	1	5322 121 44028	Suppressing capacitor

3.8.2. Electrical parts

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identificat marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegev De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications so indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de u marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,5 W ≦ 5 MΩ, 1%
> 5 ≦ 10 MΩ, 2%
> 10 MΩ, 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,5 W ≦1,5MΩ, 5%
>1,5MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
10 W 5%

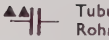
Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
1 W ≦ 2,2 MΩ, 5
>2,2 MΩ, 10

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
2 W 5

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
0,4 – 1,8 W 0,5

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
5,5 W ≦ 200 Ω, 10
>200 Ω, 5

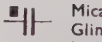
Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
500 V



Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
700 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
500 V

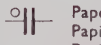
"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
30 V



Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
400

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
250



Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
1000

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

3.8.2.1. Resistors

Item	Fig.	Order number	Value	Description
601a	5	5322 102 10136	10 kΩ	Double potentiometer
601b	5		10 kΩ	
603	5	5322 101 40073	470 kΩ	Potentiometer with switch
604	5	5322 101 20421	2.2 MΩ	Potentiometer

Item.	Order number	Value	Watt/ 70°C	%	Description
UNIT 1A, UNIT 1B					
602	5322 101 44003	4.7 kΩ			Potentiometer with switch
610	5322 111 20321	900 kΩ	0.5	1	Carbon
611	5322 116 50461	111 kΩ	0.5	1	Carbon
612	5322 111 20331	990 kΩ	0.5	1	Carbon
613	5322 116 50229	10.1 kΩ	0.5	1	Carbon
614	5322 111 20317	1.0 MΩ	0.5	1	Carbon
615	4822 111 20018	1.0 kΩ	0.5	1	Carbon
617	5322 111 20329	500 kΩ	0.5	1	Carbon
618	5322 111 20317	1.0 MΩ	0.5	1	Carbon
619	5322 111 20318	750 kΩ	0.5	1	Carbon
620	5322 116 50122	333 kΩ	0.5	1	Carbon
621	5322 111 20317	1.0 MΩ	0.5	1	Carbon
UNIT 2					
607	5322 116 54079	36 kΩ	0.33	2	Carbon
608, 609	5322 116 50109	56 kΩ	0.33	2	Carbon
610	5322 116 54079	36 kΩ	0.33	2	Carbon
611	5322 116 50158	5.1 kΩ	0.5	1	Carbon
612	5322 100 10075	100 kΩ			Potentiometer
613	5322 116 50086	220 Ω	0.5	1	Carbon
614, 615	5322 116 50801	9.1 kΩ	0.33	2	Carbon
616, 618	5322 116 50119	12 kΩ	0.5	1	Carbon
625, 626	5322 116 50537	9.1 kΩ	0.5	1	Carbon
627	4822 100 10038	470 Ω			Potentiometer
628	5322 116 50097	680 Ω	0.5	1	Carbon
657	5322 116 54079	36 kΩ	0.33	2	Carbon
658, 659	5322 116 50109	56 kΩ	0.33	2	Carbon
660	5322 116 54079	36 kΩ	0.33	2	Carbon
661	5322 116 50158	5.1 kΩ	0.5	1	Carbon
662	5322 100 10075	100 kΩ			Potentiometer
663	5322 116 50086	220 Ω	0.5	1	Carbon
664, 665	5322 116 50801	9.1 kΩ	0.33	2	Carbon
666, 668	5322 116 50119	12 kΩ	0.5	1	Carbon
675, 676	5322 116 50537	9.1 kΩ	0.5	1	Carbon
677	4822 100 10038	470 Ω			Potentiometer
678	5322 116 50097	680 Ω	0.5	1	Carbon
709, 710	5322 116 50184	33 kΩ	0.5	1	Carbon

Item	Order number	Value	Watt/70°C	%	Description
711, 712	5322 116 50927	36 kΩ	0.5	1	Carbon
715, 716	5322 116 50554	750 Ω	0.5	1	Carbon
UNIT 3					
602	5322 116 50594	120 kΩ	0.5	1	Carbon
604	5322 116 50107	43 kΩ	0.5	1	Carbon
605	5322 116 50858	200 kΩ	0.5	1	Carbon
607	4822 100 10035	10 kΩ			Potentiometer
608, 609	5322 116 50106	39 kΩ	0.5	1	Carbon
610	5322 116 50109	56 kΩ	0.5	1	Carbon
613	5322 116 50107	43 kΩ	0.33	2	Carbon
614	5322 116 50109	56 kΩ	0.33	2	Carbon
617	5322 116 50463	10 kΩ	0.5	1	Carbon
618	5322 111 20019	3 kΩ	0.5	1	Carbon
619	5322 116 50219	5.6 kΩ	0.5	1	Carbon
624	5322 116 50517	180 Ω	0.5	1	Carbon
625	5322 116 50293	1.5 kΩ	0.5	1	Carbon
626	5322 111 20022	3.9 kΩ	0.5	1	Carbon
627	5322 116 50152	8.2 kΩ	0.5	1	Carbon
628	5322 116 50584	620 Ω	0.5	1	Carbon
632	5322 100 10051	22 kΩ			Potentiometer
634	4822 116 30058	1.3 kΩ		20	N.T.C. carbon
640	5322 116 50097	680 Ω	0.33	2	Carbon
641	5322 116 50088	270 Ω	0.33	2	Carbon
642	5322 116 50103	3.9 kΩ	0.33	2	Carbon
643	5322 116 54064	2.0 kΩ	0.33	2	Carbon
647, 648	5322 100 10036	4.7 kΩ			Potentiometer
655	5322 116 50152	8.2 kΩ	0.5	1	Carbon
656	5322 116 51056	11 kΩ	0.5	1	Carbon
657	5322 116 50532	2.2 kΩ	0.5	1	Carbon
658	5322 116 50584	620 Ω	0.5	1	Carbon
659	5322 100 10052	100 kΩ			Potentiometer
660, 661	5322 116 50671	2.61 kΩ	0.4	1	Metal film
667	4822 111 20038	15 kΩ	0.5	1	Carbon
668	5322 111 20019	3 kΩ	0.5	1	Carbon
669	5322 116 50657	6.8 kΩ	0.5	1	Carbon
670	5322 116 50158	5.1 kΩ	0.5	1	Carbon
675, 676	5322 116 50275	130 kΩ	0.5	1	Carbon
677, 678	5322 112 30147	33 kΩ	0.33	2	Wire wound
693	5322 111 20019	3 kΩ	0.5	1	Carbon
694	5322 116 50114	160 kΩ	0.5	1	Carbon
705	5322 116 50226	1.3 kΩ	0.33	2	Carbon
UNIT 3A					
601	5322 111 20034	100 kΩ	0.5	1	Carbon
602	5322 116 50305	390 kΩ	0.5	1	Carbon

Item	Order number	Value	Watt/70°C	%	Description
603	5322 111 20034	100 kΩ	0.5	1	Carbon
604, 605	5322 116 50332	20 kΩ	0.5	1	Carbon
606	5322 116 50463	10 kΩ	0.5	1	Carbon
607, 608	5322 116 50941	2 kΩ	0.5	1	Carbon
609	5322 101 40078	10 kΩ			Potentiometer with switch
UNIT 4					
608	5322 101 10064	220 kΩ			Potentiometer
613	5322 100 10086	22 kΩ			Potentiometer
618	5322 112 30147	33 kΩ	8W/40°C	5	Wire wound

3.8.2.2. Capacitors

Item	Order number	Value	Volt	%	Description
501	5322 121 40013	1.0 µF	250	20	Polyester
502	5322 121 44028	10 nF	250		Suppressor
UNIT 1A, UNIT 1B					
501	4822 121 40105	100 nF	630	20	Polyester
502, 504 506, 508 510, 512	5322 125 60037	0.8-6 pF	500		Trimmer
513	4822 121 50474	2.7 nF	63	5	Polystyrene
515, 517 518, 521	5322 125 60037	0.8-6 pF	500		Trimmer
UNIT 2					
501	5322 121 40327	4.7 nF	400	10	Polyester
503, 504	4822 124 20405	470 µF	6.3		Electrolytic
505	4822 122 40019	1.0 pF	400	0.25 pF	Ceramic
507	5322 122 40085	6.8 nF	250	-20/+50	Ceramic
508	4822 122 40019	1.0 pF	400	0.25 pF	Ceramic
509	4822 125 50061	1.4-5.5 pF	100		Trimmer
510	5322 125 54001	4-30 pF	50		Trimmer
511	4822 122 40007	22 pF	400	5	Trimmer
551	5322 121 40327	4.7 nF	400	10	Polyester
553, 554	4822 124 20405	470 µF	6.3		Electrolytic
555	4822 122 40019	1.0 pF	400	0.25 pF	Ceramic
557	5322 122 40085	5.8 nF	250	-20/+50	Ceramic
558	4822 122 40019	1.0 pF	400	0.25 pF	Ceramic
559	4822 125 50061	1.4-5.5 pF	100		Trimmer
560	5322 125 54001	4-30 pF	50		Trimmer
561	4822 122 40006	18 pF	400	5	Ceramic
571, 572	5322 122 40086	68 pF	400	10	Ceramic
573, 574	4822 122 40018	15 pF	400	5	Ceramic
575, 576	5322 122 40084	0.47 pF	400	0.25 pF	Ceramic
577	4822 124 20362	22 µF	25		Electrolytic

Item	Order number	Value	Volt	%	Description
578, 579	5322 122 40085	6.8 nF	250	-20/+50	Ceramic
580	4822 124 20032	4.7 µF	250		Electrolytic
UNIT 3					
501	5322 124 20355	10 µF	25		Electrolytic
502	4822 124 20362	22 µF	25		Electrolytic
503	5322 124 20355	10 µF	25		Electrolytic
504	5322 122 30002	150 pF		2	Ceramic
505	5322 121 50373	5.6 nF	63	1	Polystyrene
507	4822 122 40083	39 pF	400	5	Ceramic
508	5322 124 20411	640 µF	10		Electrolytic
510	4822 122 40005	33 pF	400	5	Ceramic
511	5322 122 40078	1.5 nF	400	-20/+50	Ceramic
512	5322 121 50373	5.6 nF	63	5	Polystyrene
513	4822 122 40011	10 pF	400	5	Ceramic
514	4822 121 50413	470 pF	125	1	Polystyrene
515	5322 122 30103	22 nF	40	-20/+100	Ceramic
516	5322 121 50368	820 pF	125	5	Polystyrene
517	4822 122 40006	18 pF	400	5	Ceramic
518	4822 122 40018	15 pF	400	5	Ceramic
519	5322 122 40084	0.47 pF	400	0.25 pF	Ceramic
520	5322 121 40231	150 nF	100	10	Polyester
521	5322 122 10107	100 nF	30	-20/+80	Ceramic
522	5322 122 40078	1.5 nF	400	-20/+50	Ceramic
UNIT 3A					
501	4822 121 40266	4.7 µF	100	10	Polyester
502	5322 121 50375	47 nF	63	1	Polystyrene
503	4822 124 20351	6.4 µF	40		Electrolytic
504	5322 121 40094	68 nF	100	10	Polyester
505	4822 120 10036	2.2 pF	250	0.5 pF	Ceramic
506	4822 122 10052	220 pF	400	5	Ceramic
UNIT 4					
501	5322 122 20018	100 pF	2000	10	Ceramic
502	5322 121 40197	1.0 µF	100	20	Polyester
503	5322 121 40257	330 nF	100	20	Polyester
504	5322 121 40197	1.0 µF	100	20	Polyester
505, 506 507	5322 122 50044	1.0 nF	3000	-20/+50	Ceramic
510	5322 122 30134	10 nF	3000	-20/+50	Ceramic
511	5322 121 40175	470 nF	100	10	Polyester
512	4822 121 50044	1.0 nF	3000	-20/+50	Ceramic
513	5322 122 30134	10 nF	3000	-20/+50	Ceramic
521, 522	5322 124 20597	2200 µF	40		Electrolytic

Item	Order number	Value	Volt	%	Description
523	5322 124 20598	470 μF	63		Electrolytic
524	5322 124 40059	100 μF	300		Electrolytic
525	5322 124 40116	64 μF	500		Electrolytic
526	5322 124 40078	250 μF	200		Electrolytic

3.8.2.3. Semi-conductors

Item	Type	Order number	Description
UNIT 2			
311, 312	BF194	5322 130 40303	Silicon transistor
313, 314	AF121	5322 130 40385	Germanium transistor
315, 316	BF196	5322 130 40376	Silicon transistor
361, 362	BF194	5322 130 40303	Silicon transistor
363, 364	AF121	5322 130 40385	Germinum transistor
365, 366	BF196	5322 130 40376	Silicon transistor
367, 371, 372	BF194	5322 130 40303	Silicon transistor
373, 374	BSX20	5322 130 40417	Silicon transistor
375, 376, 377, 378	BF178	5322 130 40299	Silicon transistor
401 451	BZX70-C12	5322 130 34127	Selected diode pair
402	BZX79-C6V2	5322 130 30766	Silicon zener diode
403 up to 408	BAX13	5322 130 40182	Silicon diode
452	BZX79-C6V2	5322 130 30766	Silicon zener diode
453 up to 458	BAX13	5322 130 40182	Silicon diode
461 up to 464	BAX13	5322 130 40182	Silicon diode
465, 466	BZX79-C6V2	5322 130 30766	Silicon zener diode
467, 468	BAX13	5322 130 40182	Silicon diode
UNIT 3			
301, 302	BF196	5322 130 40376	Silicon transistor
303, 304, 305, 306	BF194	5322 130 40303	Silicon transistor
307	BSW33	5322 130 40538	Silicon transistor
308, 309, 310	BF194	5322 130 40303	Silicon transistor
311	BC159	5322 130 40508	Silicon transistor
312	BSX20	5322 130 40417	Silicon transistor
313	BC148C	4822 130 40361	Silicon transistor
314	BC148	5322 130 40318	Silicon transistor
315, 316, 317	BF194	5322 130 40303	Silicon transistor
318, 319	BC148C	4822 130 40361	Silicon transistor
320, 321	BF179	5322 130 40661	Silicon transistor
322 up to 326	BF194	5322 130 40303	Silicon transistor
327	BF178	5322 130 40299	Silicon transistor
328, 329	BF194	5322 130 40303	Silicon transistor
401 up to 407	BAX13	5322 130 40182	Silicon diode
408	AAZ17	5322 130 30283	Germanium diode
409	BZY88-C7V5	5322 130 30287	Silicon zener diode
410	AAZ17	5322 130 30283	Germanium diode
411 up to 415	BAX13	5322 130 40182	Silicon diode
416, 417	BZX70-C12	5322 130 30753	Silicon zener diode

Item	Type	Order number	Description
UNIT 4			
301	BC158	5322 130 40476	Silicon transistor
302	BC148C	4822 130 40361	Silicon transistor
303	BFY50	5322 130 40294	Silicon transistor
401	BZY88-C6V2	5322 130 30286	Silicon zener diode
402, 403, 404	BYX10	5322 130 30195	Silicon rectifier diode
405, 406	BAX13	5322 130 40182	Silicon diode
410	BY164	5322 130 30414	Rectifier
411, 412, 413	BYX10	5322 130 30195	Silicon rectifier diode

3.8.3. Parts of attenuator probes PM 9326 and PM 9327 (Fig. 14)

Item	Qty	Order number	Description
a	1	5322 320 10042	Probe cable 2m for PM 9327
	1	5322 321 20087	Probe cable 1.15m for PM 9326
b	1	5322 321 20096	Earthing cable 15 cm
c	1	5322 321 20134	Earthing cable 30 cm
d	1	5322 266 20015	Measuring probe 1:1 (black)
e	1	5322 268 10029	Test pin
f	1	5322 268 10039	Test hook
g	1	5322 210 70044	Attenuator probe 1:10 (grey)
h	1	5322 264 20016	Test clip
	1	5322 111 20155	Resistors

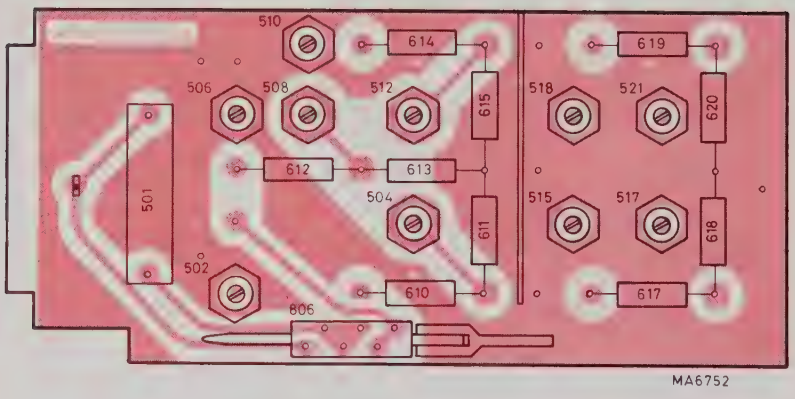


Fig. 23. Printed-wiring board, unit 1A (B)
Printplatte Unit 1A (B)
Printplaat unit 1A (B)
Platine imprimée unit 1A (B)

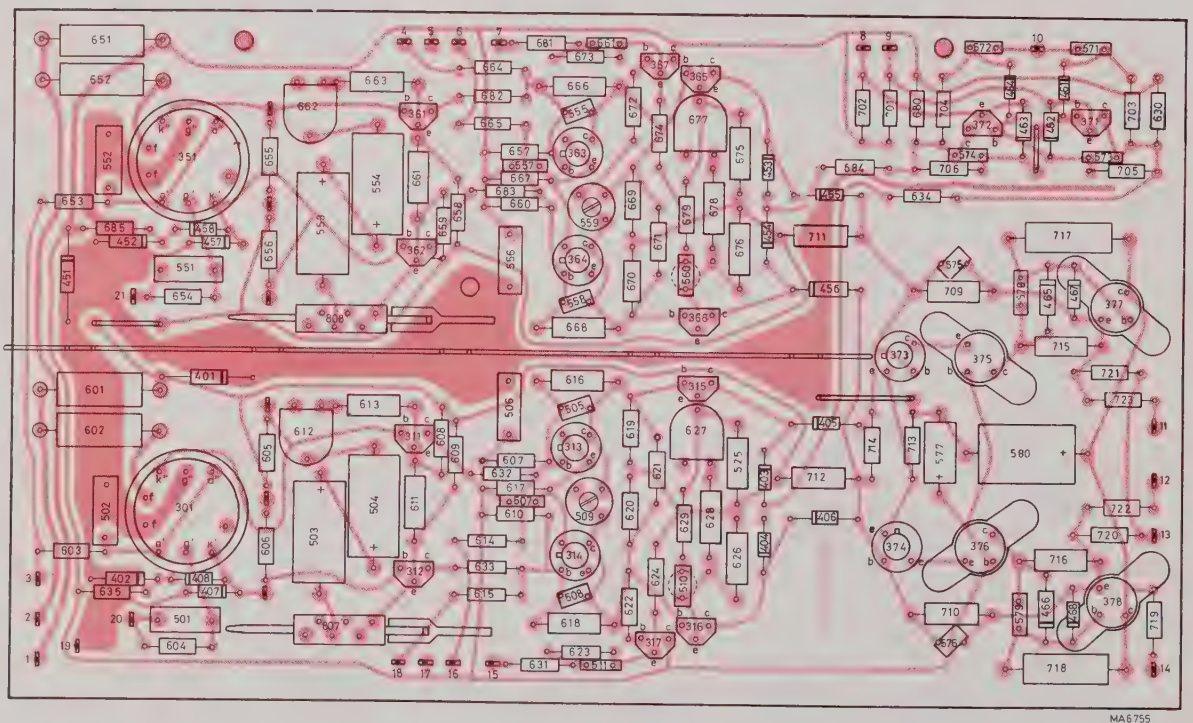


Fig. 24. Printed-wiring board, unit 2
Printplatte Unit 2
Printplaat unit 2
Platine imprimée unit 2

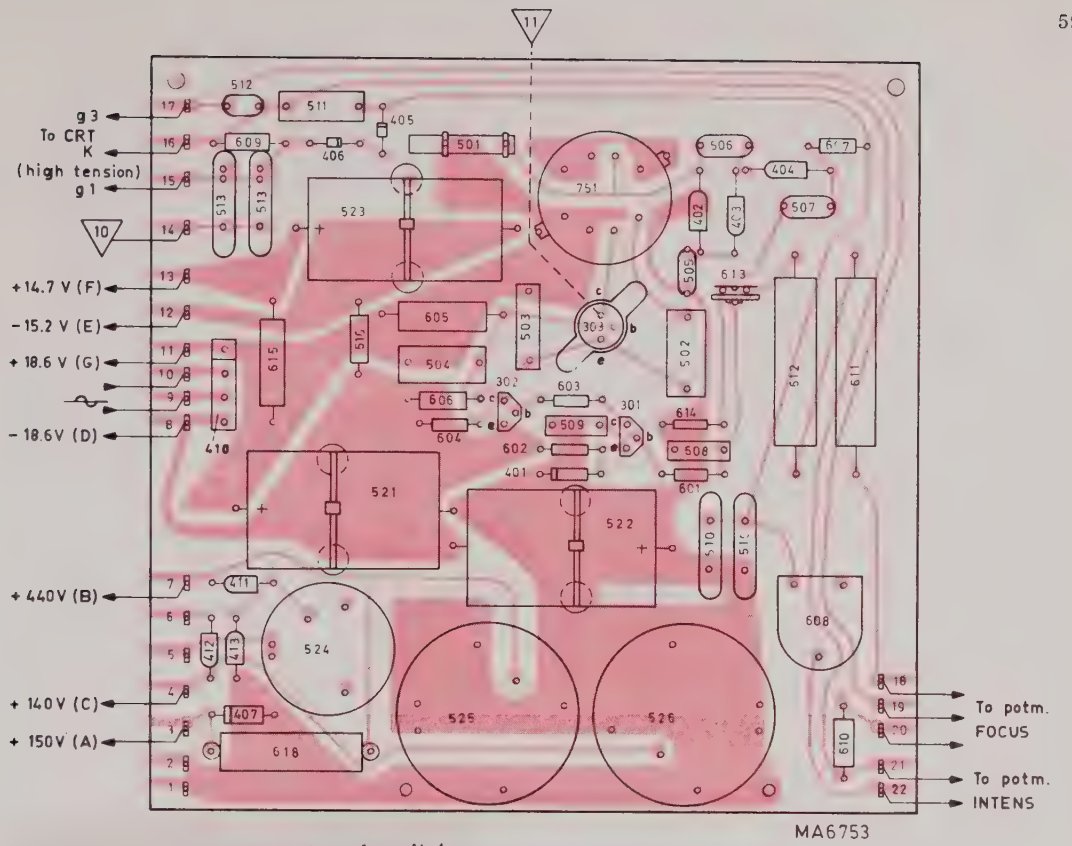


Fig. Fig. 26. Printed-wiring board, unit 4
Printplatte Unit 4
Printplaat unit 4
Platine imprimée unit 4

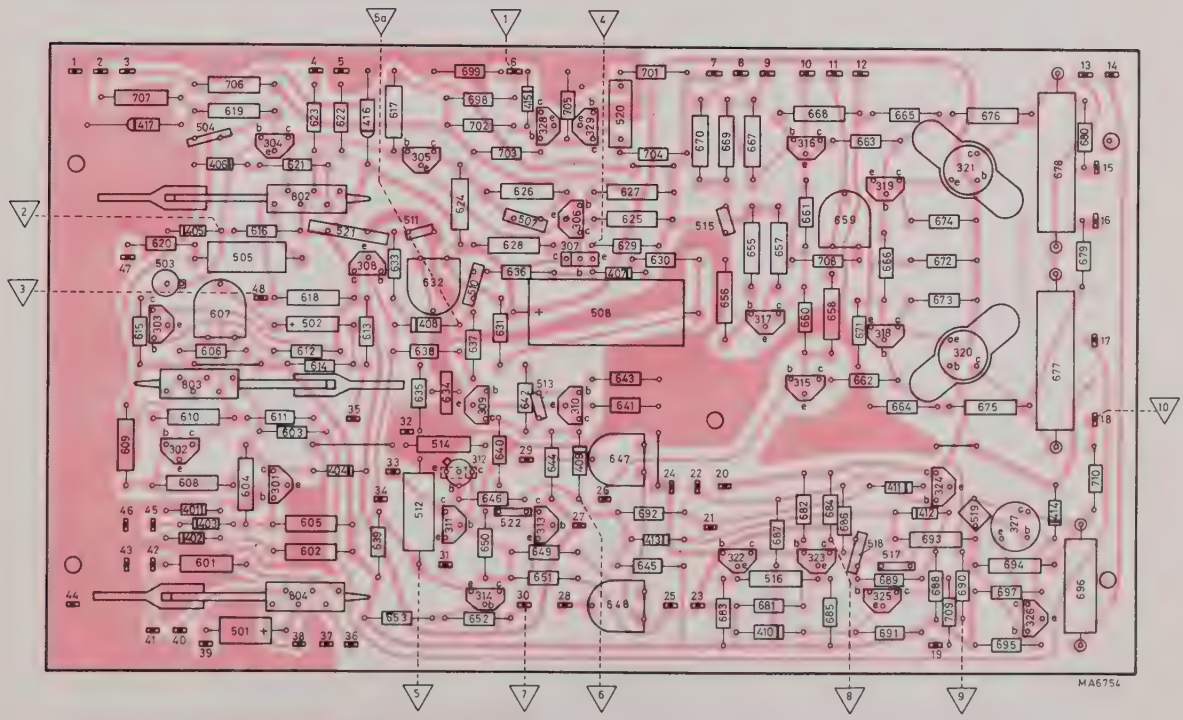
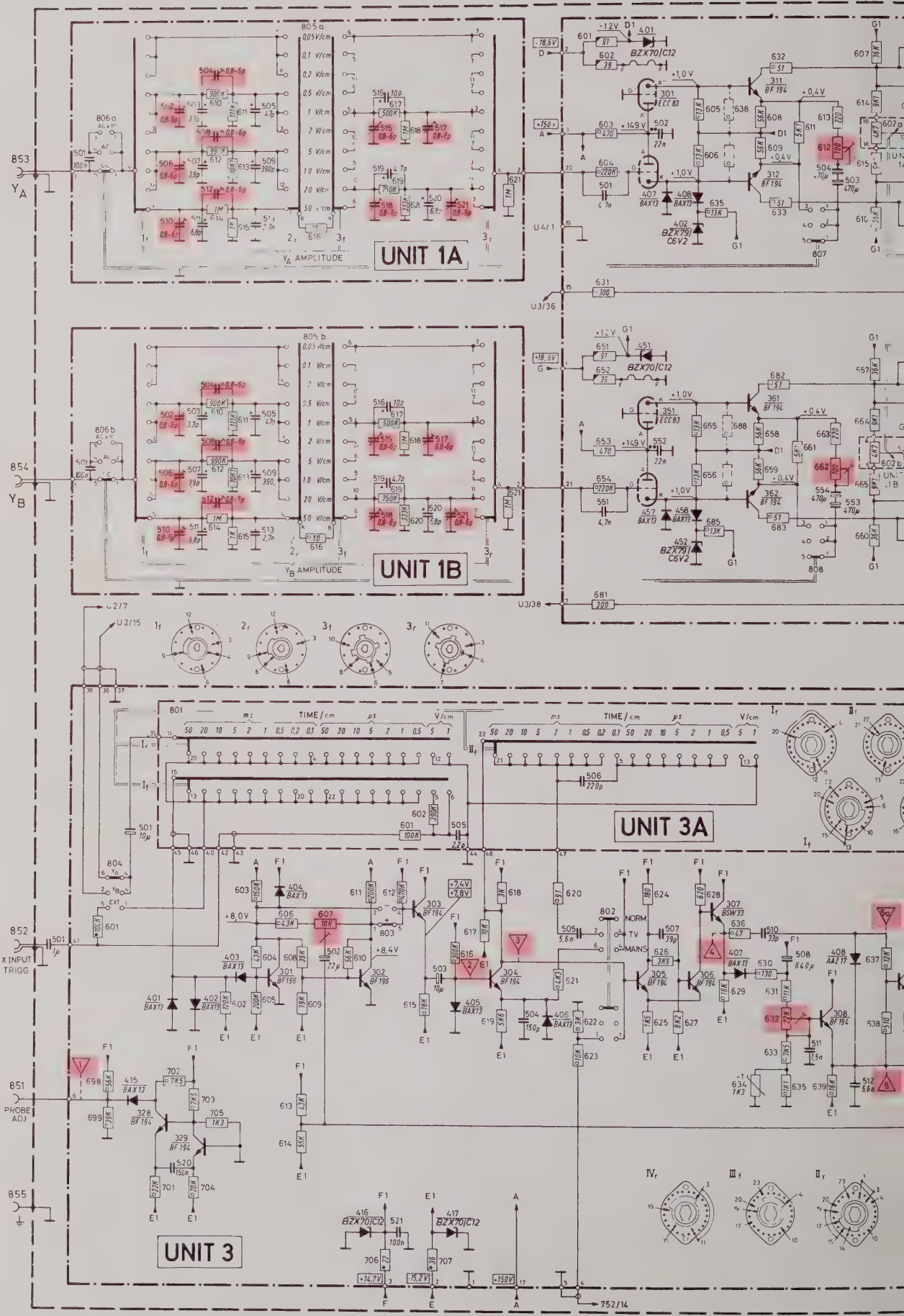
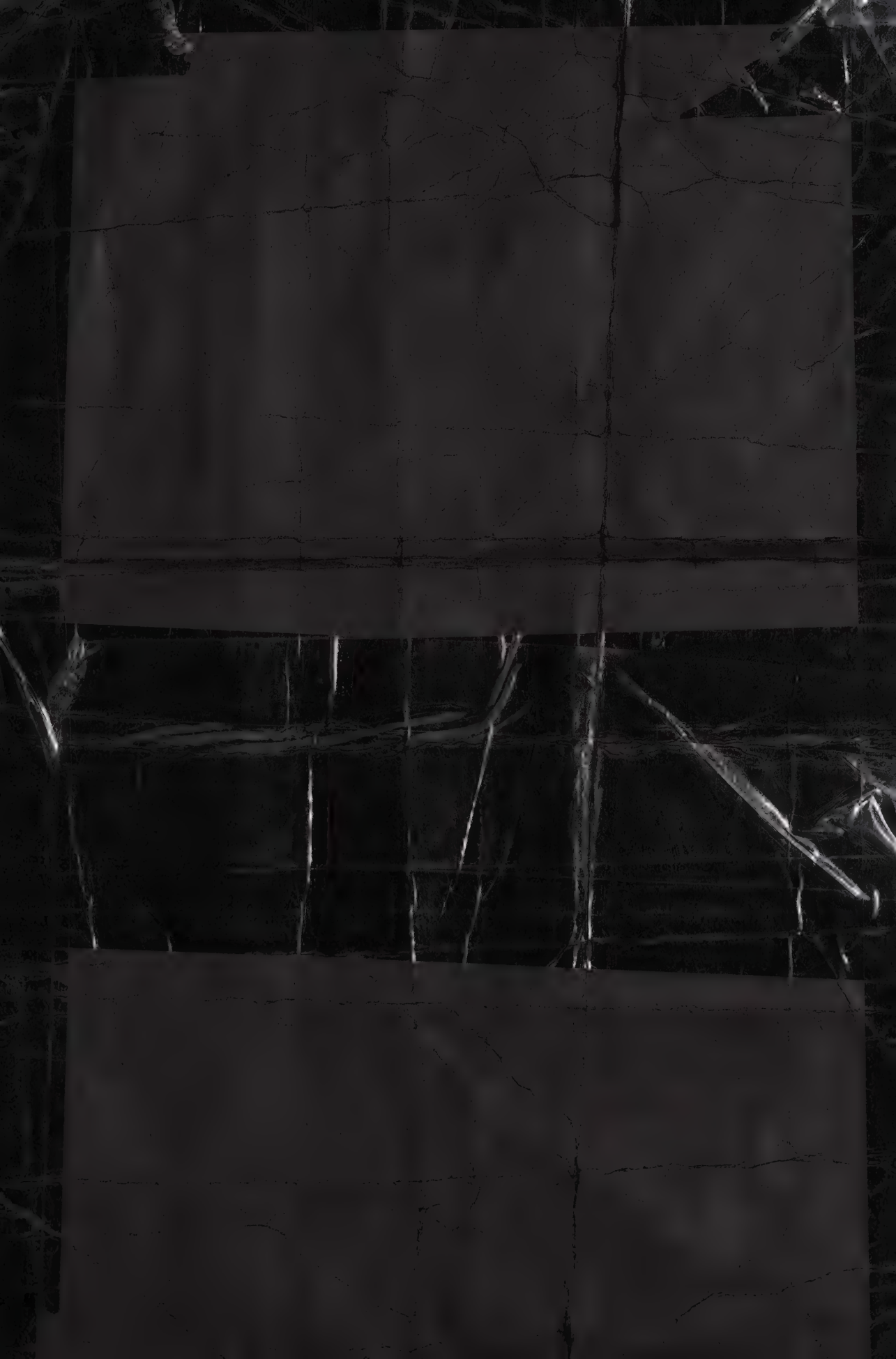
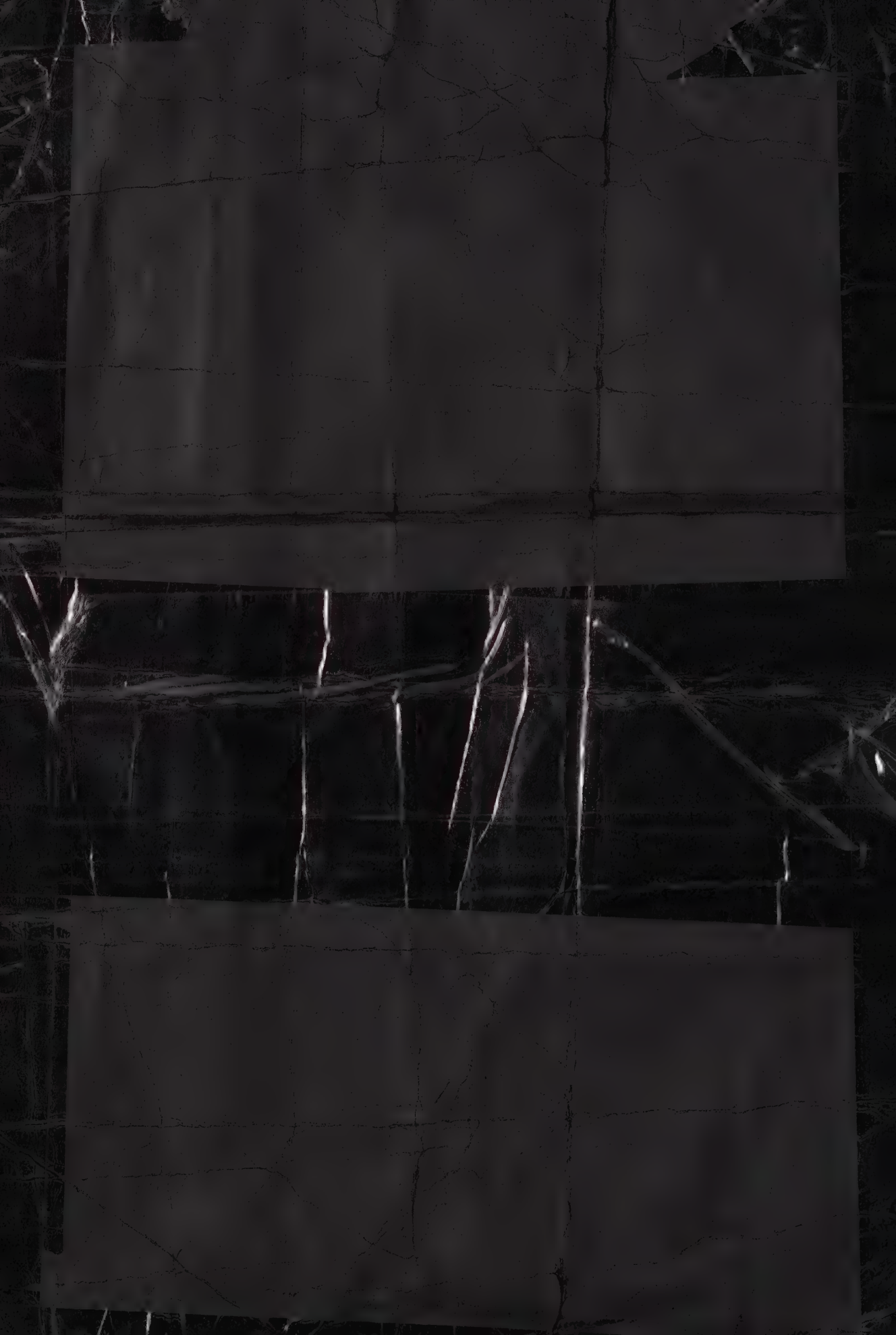
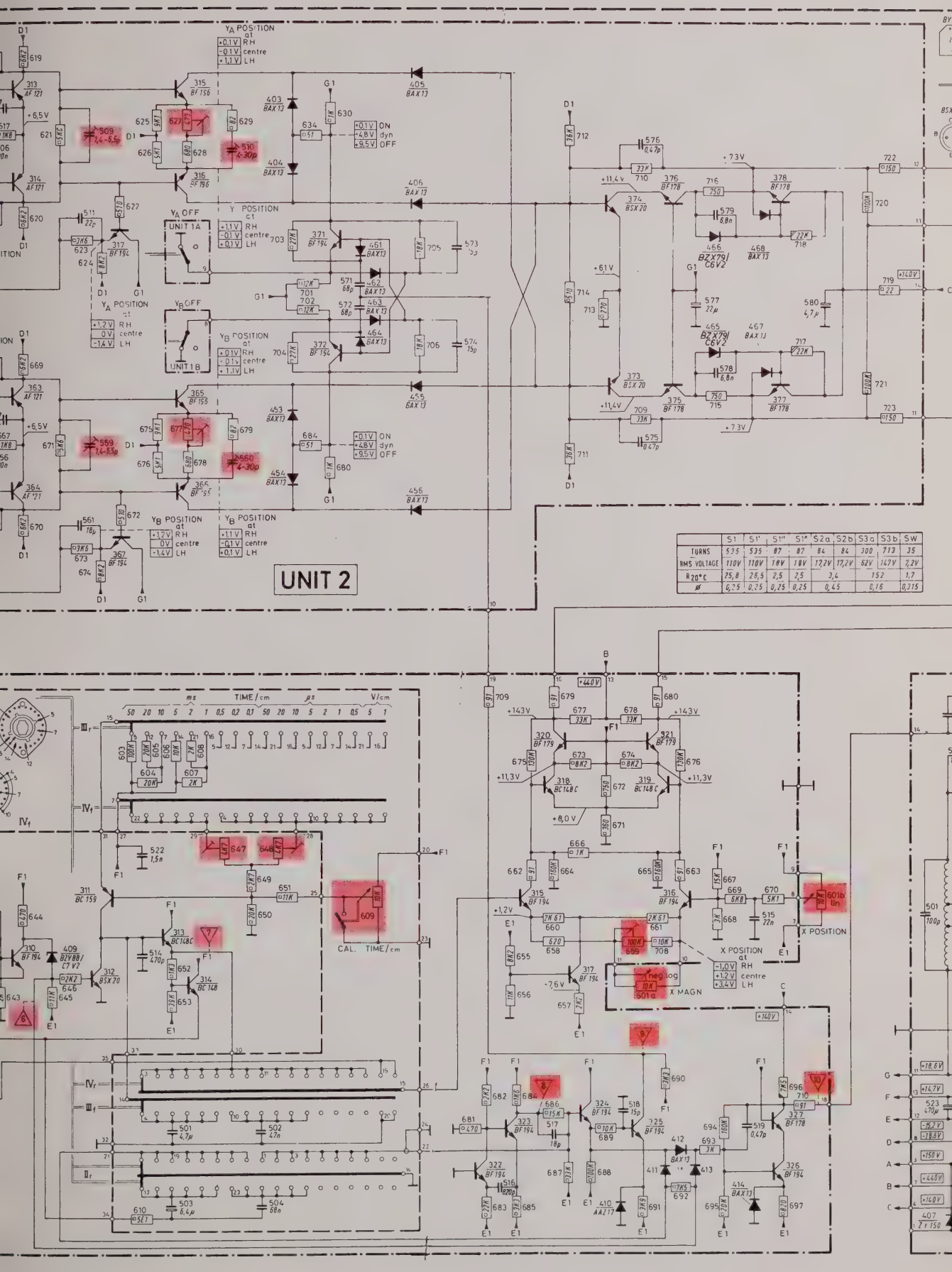


Fig. Fig. 25. Printed-wiring board, unit 3
Printplatte Unit 3
Printplaat unit 3
Platine imprimée unit 3

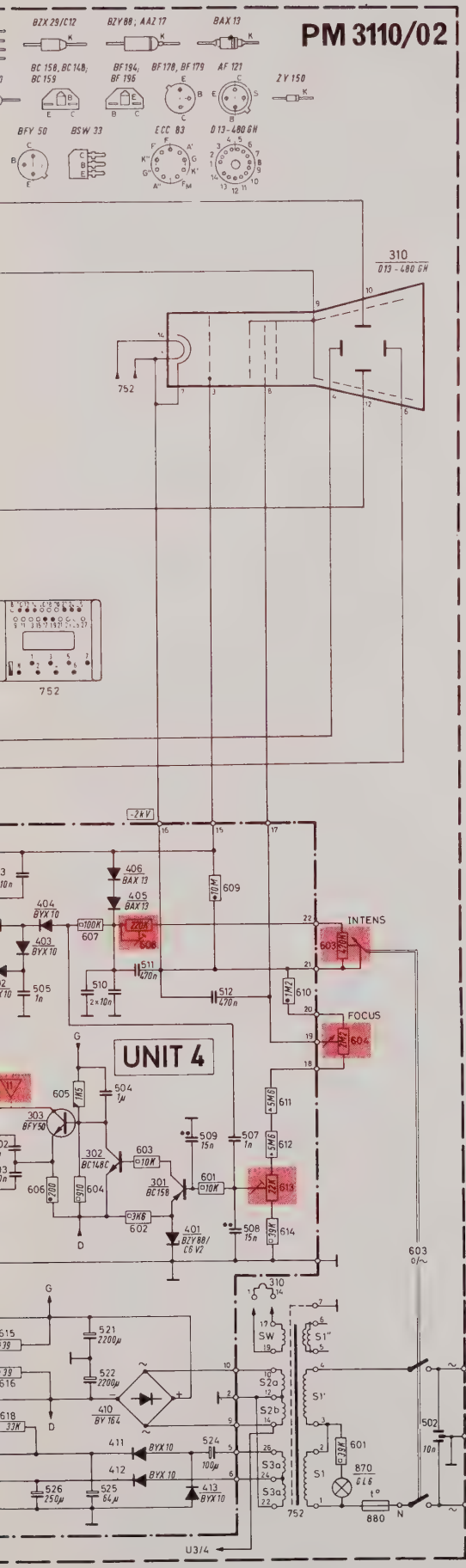

UNIT 1A
UNIT 1B
UNIT 3A
UNIT 3
Y_A AMPLITUDE
Y_B AMPLITUDE
TIME / cm
X INPUT TRIGG
PROBE ADJ
NORM
TV
MAINS
BZX70/C12
BZX79/C6V2
752/14







	S1	S1'	S1''	S1*	S2a	S2b	S3a	S3b	SW
TURNS	535	535	87	87	84	84	300	713	35
RMS VOLTAGE	110V	110V	18V	18V	17,2V	17,2V	62V	147V	7,2V
R 20°C	25,8	26,5	2,5	2,5	2,4		15Ω		1,7
Ø	0,25	0,25	0,25	0,25	0,45		0,16		0,315



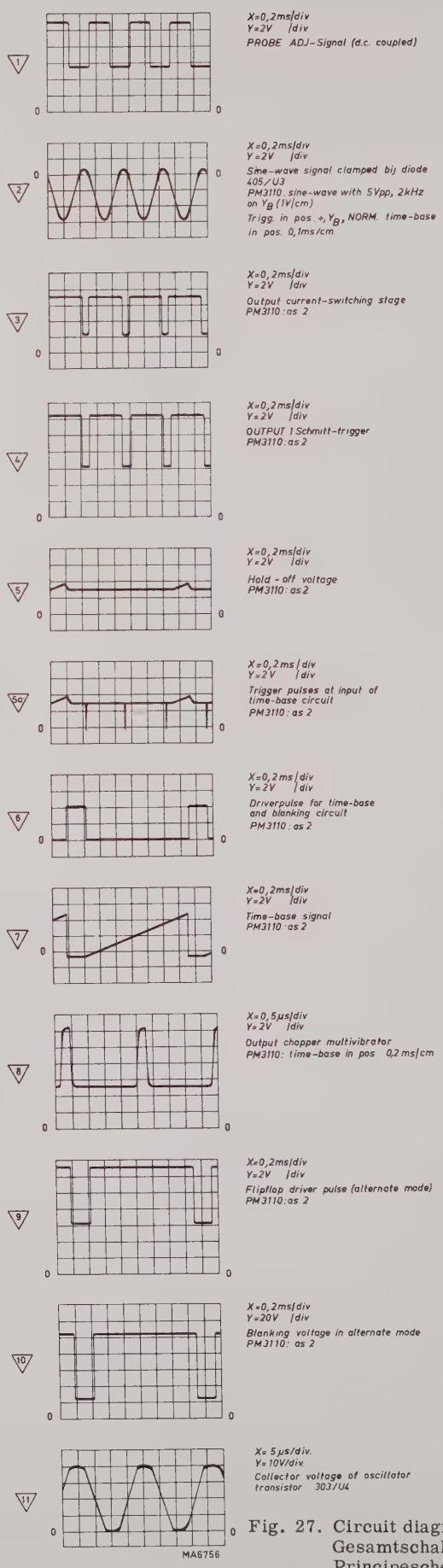


Fig. 27. Circuit diagram
Gesamtschaltbild
Principeschema
Schéma général de principe

QUALITY REPORTING

CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.
For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

LOCATION

□□□

Unit number
e.g. 000A or 0001 (for unit A or 1; not 00UA or 00U1)

or: Type number of an accessory (only if delivered with the equipment)
e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable
0000

CATEGORY

□

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

COMPONENT/SEQUENCE NUMBER

□□□□

Enter the identification as used in the circuit diagram, e.g.:

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
R0....	Resistor, potentiometer
C0....	Capacitor, variable capacitor
B0....	Tube, valve
LA....	Lamp
VL...	Fuse
SK....	Switch
BU....	Connector, socket, terminal
T0....	Transformer
L0....	Coil
X0....	Crystal
CB....	Circuit block
RE....	Relay
ME....	Meter, indicator
BA....	Battery
TR....	Chopper

Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type numbe
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

PERRY-MEASURING INSTRUMENTS INC.
A NORTH AMERICAN PHILIPS COMPANY
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HICKSVILLE, NEW YORK 11802

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